Addendum

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Paper 64
Entered: August 11, 2016

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SILICON LABORATORIES, INC.,
Petitioner,

v.

CRESTA TECHNOLOGY CORP. and CF CRESPE LLC,
Patent Owner.

Case IPR2015-00615
Patent 7,075,585 B2

Before PHILLIP J. KAUFFMAN, GREGG I. ANDERSON, and PATRICK M. BOUCHER, *Administrative Patent Judges.*

KAUFFMAN, *Administrative Patent Judge*.

FINAL WRITTEN DECISION

35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

A. PROCEDURAL OVERVIEW

Petitioner, Silicon Laboratories, Incorporated, filed a Petition (Paper 1, "Pet.") to institute an *inter partes* review of claims 11–15 and 20 (the "challenged claims") of U.S. Patent No. 7,075,585 B2 (Ex. 1001, the "'585 patent"). Patent Owner, then Cresta Technology Corporation, timely filed a Preliminary Response (Paper 8, "Prelim. Resp."). In the Decision to Institute (Paper 9, "Dec."), we instituted trial on all of the challenged claims.

Subsequently, Patent Owner filed a Patent Owner Response (Paper 16, "PO Resp."), and Petitioner filed a Reply (Paper 20, "Pet. Reply").

Patent Owner's contention that portions of Petitioner's Reply are beyond the scope of Patent Owner's Response is discussed in Section II. Patent Owner submitted observations on cross-examination of Petitioner's expert, Dr. Holberg, and Petitioner submitted a reply. Papers 31, 36. We considered this information.[1] Patent Owner did not file a motion to amend. Patent Owner filed a motion to exclude certain evidence which is discussed in Section II below.

Prior to Due Date 5, Cresta Technology Corporation filed for bankruptcy, and the Board suspended all deadlines in the case. *See* Paper 39 (notifying the Board); Paper 40 (ordering all deadlines suspended until further notice). Subsequently, the '585 patent was assigned to CF CRESPE LLC, Cresta's counsel was retained, and this proceeding resumed. Papers 46 (defining the remaining schedule), 53 (CF CRESPE LLC power of attorney),

[1] Generally, we were persuaded by Petitioner's response to these observations.

54 (mandatory notice), 56 (motion to add Patent Owner), 58[2] (granting motion).

Oral hearing was held on Wednesday, June 1, 2016, and a transcript of the oral hearing is included in the record.[3] Paper 63 ("Tr.").

We have jurisdiction under 35 U.S.C. § 6(c). This Decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of the claims on which we instituted trial. For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 11–15 and 20 of the '585 patent are unpatentable.

B. RELATED PROCEEDINGS

Patent Owner asserted the '585 patent against Petitioner in *Cresta Technology Corp. v. Maxlinear, Inc.*, Case No. 1:14-cv-00079-RGA (D.Del), and U.S. International Trade Commission Investigation No. 337-TA-910 ("the ITC proceeding"). *See* Pet. 1–2; Ex. 1002; Ex. 1003.

Petitioner and Petitioner's co-defendant in these proceedings, MaxLinear, Inc., have filed the following petitions:

1. IPR2014-00728 ("the '728 IPR") (US 7,075,585 B2)

We determined that claims 1–3, 5, 10, and 16–19 are unpatentable. *Silicon Laboratories, Inc. v. Cresta Technology Corp.*, Case IPR2014-00728, (PTAB Oct. 21, 2015) (Paper 53).[4] Patent Owner has appealed. Paper 55.

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[2] Erratum at Paper 61.

[3] The hearing was held in conjunction with the hearing for IPR2015-00626, and a single transcript was produced.

[4] A copy of this paper is at Ex. 1062.

2. IPR2014-00809 (US 7,265,792 B2, "the '809 IPR")

We determined that claims 1–17 of the '792 are unpatentable. *Silicon Laboratories, Inc. v. Cresta Technology Corp.*, Case IPR2014-00809 (PTAB Oct. 21, 2015) (Paper 56). Patent Owner has appealed. Paper 58.

3. IPR2015-00881 (US 7,251,466 B2, "the '466 patent")

We determined that claims 1, 2, 5, 8, 12, 13, 20, 21, 25, 26, 31, 32, 35, and 36 of the '466 patent are unpatentable. *Silicon Labs., Inc. v. Cresta Tech. Corp.*, Case IPR2014-00881 (PTAB Oct. 21, 2015) (Paper 47).

4. IPR2015-00591 (US 7,075,585 B2)

We denied institution of a trial. *MaxLinear, Inc., v. Cresta Technology Corp.*, Case IPR2015-00591 (PTAB June 15, 2015) (Paper 9).

5. IPR2015-00592 (US 7,075,585 B2)

We instituted trial of claims 1–21. *MaxLinear, Inc., v. Cresta Technology Corp. and CF CRESPE LLC*, Case IPR2015-00592 (PTAB Aug. 14, 2015) (Paper 9). Oral hearing was held in conjunction with IPR2015-00594 on June 3, 2016.

6. IPR2015-00593 (US 7,265,792 B2)

We denied institution of a trial. *MaxLinear, Inc., v. Cresta Technology Corp.*, Case IPR2015-00593 (PTAB Aug. 14, 2015) (Paper 9).

7. IPR2015-00594 (US 7,265,792 B2)

We instituted trial of claims 1–29. *MaxLinear, Inc., v. Cresta Technology Corp. and CF CRESPE LLC*, Case IPR2015-00594 (PTAB Aug. 21, 2015) (Paper 13). Oral hearing was held in conjunction with IPR2015-00592 on June 3, 2016.

8. IPR2015-00626 (US 7,265,792 B2)

We instituted trial of claims 18, 19, and 24–29. *See Silicon Laboratories, Inc. v. Cresta Technology Corp. and CF CRESPE LLC*, Case IPR2014-00626 (PTAB Aug. 14, 2015) (Paper 9).

II. PRELIMINARY MATTERS

A. 35 U.S.C. § 325(d)

In our Institution Decision, we declined to exercise our discretion to deny the Petition under § 325(d). Dec. 24–25. Patent Owner did not seek rehearing of that determination. In the Response, Patent Owner "disagrees" with our determination in the Institution Decision, "[f]or the reasons discussed in the Preliminary Response," and "reserves the right" to raise the issue on appeal to the Federal Circuit. PO Resp. 3–4.

Patent Owner does not present new argument or evidence, nor expressly ask that the Petition at hand be denied based on 35 U.S.C. § 325(d).

Given this, there is no question before us on this issue.

B. PERSON OF ORDINARY SKILL IN THE ART

Petitioner contends that a person of ordinary skill in the art would have a Master of Science or higher degree in electrical engineering, and have at least four years of experience with mixed signal system design, including analog front ends and subsequent digital signal processing of various analog and digital signal formats of video and audio content. Pet. 22; Ex. 1009 ¶ 26.

Patent Owner argues that Petitioner's definition is incomplete in that a person of ordinary skill would need at least two years of experience in implementing radio-frequency circuits for television applications due to the unique challenges of television applications. PO Resp. 4; Ex. 2003 ¶¶ 19–20, 22; Ex. 2032 ¶¶ 18–25.[5]

As an initial matter, we disagree with Patent Owner's characterization that Petitioner's definition excludes experience with television applications. Though not explicit, Petitioner's definition of four years of experience with mixed signal system design fairly includes television applications. *See* Pet. 22. Further, Patent Owner's citation to the testimony of its expert, Ion E. Opris, Ph.D., ignores that Dr. Opris testifies that a person of ordinary skill in the art would need "at least two years of professional experience in implementing radio-frequency circuits for television applications *or similar circuits*." Ex. 2032 ¶ 20 (emphasis added).

Patent Owner's definition does not differ significantly from Petitioner's. Experience is but one of several factors that may be considered when determining the level of ordinary skill in the art.[6] That is, the distinction Patent Owner identifies relates to a portion of one factor (education) in a determination involving several factors.

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[5] Exhibits 2003 and 2032 are declarations from Dr. Opris, Patent Owner's expert.

[6] *See, e.g., In re GPAC*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) ((A) "type of problems encountered in the art;" (B) "prior art solutions to those problems;" (C) "rapidity with which innovations are made;" (D) "sophistication of the technology; and" (E) "educational level of active workers in the field. [] In a given case, every factor may not be present, and one or more factors may predominate.").

Perhaps most importantly, the significance of the level of ordinary skill in the art is the role it plays in an obviousness analysis. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966); *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) ("[T]he level of skill in the art is a prism or lens through which a judge, jury, or the Board views the prior art and the claimed invention."); *Ryko Mfg. Co. v. Nu-Star, Inc*., 950 F.2d 714, 718 (Fed. Cir. 1991) ("[t]he importance of resolving the level of ordinary skill in the art lies in the necessity of maintaining objectivity in the obviousness inquiry"). Patent Owner has not explained persuasively how the alleged omission by Petitioner impacted the obviousness analysis.

Petitioner's definition, along with the prior art of record reflects an appropriate skill level. *See Okajima*, 261 F.3d at 1355.

C. PATENT OWNER'S MOTION TO EXCLUDE EVIDENCE

Patent Owner moves to exclude: Balaban (Ex. 1053), paragraphs 33–44 of Dr. Holberg's Reply Declaration (Ex. 1061), and paragraph nine of Dr. Holberg's Supplemental Declaration (Ex. 1063). Paper 30 ("Mot."). Petitioner submitted an opposition, and Patent Owner replied to that opposition. Paper 37 ("Opp."); Paper 55 ("Reply"). For the reasons that follow, Patent Owner's motion is *denied*.

The challenged exhibits were submitted on Friday, January 29, 2016, in association with Petitioner's Reply, and Patent Owner timely filed objections on Thursday, February 4, 2016.[7] Pet. Reply; Ex. 1053; Ex. 1061;

[7] With an exception for Paragraph 9 of Dr. Holberg's Supplemental Declaration as discussed below.

Paper 22 (objections); 37 C.F.R. § 42.64(b)(1). Petitioner does not challenge the sufficiency of the objections. Opp. 1–7.

Patent Owner also contends that Paper 24 contains objections. *See* Mot. 1. Paper 24 is a transcript of a telephone conference with the parties held on February 22, 2016, in which Patent Owner asserted that portions of Petitioner's Reply were beyond the scope of Patent Owner's Response and that Petitioner's Reply improperly incorporated certain material. *See* Paper 25 (transcript), 1; Paper 27 (subsequent associated order), 1. The issues raised by Patent Owner do not relate to admissibility and, therefore, are not effective evidentiary objections. *See* 37 C.F.R. §§ 42.61–64. Further, the call was not timely because it was held more than five business days after the evidence at issue was served. 37 C.F.R. § 42.64(b)(1).

1. Balaban

According to Patent Owner, Petitioner relies upon Balaban (Ex. 1053) to disclose a claim element, and such reliance is improper because Balaban was not a basis of one of the instituted grounds of unpatentability, and is neither supplemental information nor supplemental evidence. Mot. 1–3; Reply 1–3 (citing *Intelligent Bio-Systems, Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359 (Fed. Cir. 2016)).

We agree with Petitioner that Patent Owner raises concerns other than admissibility. *See* Opp. 1; *see also* 37 C.F.R. §§ 42.61–64 (regarding admissibility and the Federal Rules of Evidence). If a reply raises a new issue or belatedly presents evidence, the remedy is not to exclude that reply; rather, the remedy is that the reply is not considered. *See* 37 C.F.R. §§ 42.23(a), 42.104; Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,767 (Aug. 14, 2012).

2. Paragraphs 33–44 of Dr. Holberg's Reply Declaration

Patent Owner asserts that the supporting sections of Dr. Holberg's Reply Declaration (Ex. 1061) should be excluded because Petitioner construed "carrier signal" in Petitioner's Reply rather than in the Petition as required by 37 C.F.R. § 42.104(b). Mot. 4–7; Reply 3–4. Patent Owner adds that these supporting sections are also improperly incorporated by reference in violation of 37 C.F.R. § 42.6(a)(3). Mot. 4–7; Reply 3–4.

Here, as with the prior exhibit, Patent Owner's concerns do not go to admissibility and, therefore, are not the proper subject of a motion to exclude evidence.

3. Paragraph 9 of Dr. Holberg's Supplemental Declaration

As mentioned above, Patent Owner's objections were timely; however, Patent Owner made no objection to Dr. Holberg's Supplemental Declaration (Ex. 1063). *See* Paper 22. As Petitioner was not afforded an opportunity to correct in the form of supplemental evidence, Patent Owner's motion is deficient on this basis. *See* 37 C.F.R. § 42.64. Even considering Patent Owner's Motion with regard to this exhibit, Patent Owner's contention that Petitioner improperly incorporates portions of Dr. Holberg's Supplemental Declaration in violation of 37 C.F.R. § 42.6(a)(3) does not go to admissibility and, therefore, is not the proper subject of a motion to exclude evidence.

4. Conclusion

Patent Owner has not persuaded us that any of the challenged exhibits should be excluded. *See* 37 C.F.R. §§ 42.20(c), 42.22.

D. WEIGHT OF DR. HOLBERG'S TESTIMONY

In the Response, Patent Owner argues that Dr. Holberg's testimony should be given little or no weight for three reasons. Before addressing each of those reasons, we note that our rules provide that the opinion of an expert witness may be given little or no weight if the expert does not disclose the underlying facts or data on which the opinion relies. *See* 37 C.F.R. § 42.65. Patent Owner makes no such assertion here, and cites no other supporting authority. *See* PO Resp. 47–49.

First, according to Patent Owner, Dr. Holberg lacks ordinary skill in the art of the invention and, therefore, is not qualified to provide an opinion on any issues in this proceeding. PO Resp. 47–49 (citing Ex. 2003 ¶ 22). Although Patent Owner did not make a motion to exclude Dr. Holberg's testimony on this basis, Dr. Holberg need not be a person of ordinary skill in the art to testify as an expert under Federal Rule of Evidence 702. *See Sundance, Inc. v. DeMonte Fabricating Ltd.*, 550 F.3d 1356, 1363–64 (Fed. Cir. 2008). Nor must Dr. Holberg's qualifications perfectly match the patent as issue. *See SEB S.A. v. Montgomery Ward & Co. Inc.*, 594 F.3d 1360, 1373 (Fed. Cir. 2010). Patent Owner's argument is directed to the entirety of Dr. Holberg's testimony, essentially an assertion that we cannot give weight to anything Dr. Holberg said. Such a broad contention is less persuasive than targeting specific portions of Dr. Holberg's testimony. Further, Dr. Holberg's qualifications align with the challenged subject matter sufficiently so that his knowledge is helpful in understanding the evidence and determining facts in issue. For example, Dr. Holberg has over 30 years of experience in the electronics field, including experience in business and academic environments. Ex. 1009 ¶ 3. Dr. Holberg is a named inventor on

numerous patents and has written numerous publications. *Id.* at App. A. Additionally, Dr. Holberg has a Bachelor degree in electrical engineering, as well as a Master of Science degree, and a Ph.D. *Id.*

Second, Patent Owner contends that Dr. Holberg's credibility was called into question by his inconsistent answers regarding his compensation rates. PO Resp. 48. Specifically, Patent Owner contends that Dr. Holberg stated there was no other matter that he worked on for Petitioner where he was paid a rate other than $275 per hour, when in fact Dr. Holberg was paid a rate other than $275 per hour (i.e., $400 per hour) for trial preparation work for the related litigation. PO Resp. 48–49 (citing Ex. 2033, 18:1–8; Ex. 2031 ¶ 10).

The deposition testimony cited by Patent Owner must be considered in context. *See* PO Resp. 48–49. Regarding compensation rates, Patent Owner's counsel initially asked if Dr. Holberg was being paid at a rate of $275 hour, and Dr. Holberg clarified that he was paid $275 per hour for analysis and $400 for depositions. Ex. 2033, 17:2–7 (first inquiry). Patent Owner's counsel then repeated Dr. Holberg's answer and asked if it had been stated correctly. Dr. Holberg indicated that it was stated correctly. *Id.* at 17:8–12 (second inquiry). Patent Owner's counsel then asked if the $275 per hour rate applied to "some of the other ongoing matters" between the parties. *Id.* at 17:13–17 (third inquiry). On request, Patent Owner's counsel restated the question and asked if the $275 per hour rate applied to "other matters that are currently pending" between the parties. *Id.* at 17:18–23 (fourth inquiry). Dr. Holberg asked which "matters" Patent Owner's counsel was referring to, and Patent Owner's counsel provided the ITC proceeding as an example. *Id.* at 17:24–25 (fifth inquiry). Dr. Holberg replied that the

$275 rate applied to the ITC related work he did for Petitioner. *Id.* at 18:2–4. Patent Owner's counsel then asked if there are there "any other matters" that Dr. Holberg works on for petitioner where he was paid a rate other than $275 per hour, and Dr. Holberg indicated there was not. *Id.* at 18:5–8 (sixth inquiry).

Dr. Holberg's response was not inconsistent. It is possible, and reasonable, that Dr. Holberg did not understand the "other matters" referred to by Patent Owner's counsel to include the related litigation. As detailed above, Patent Owner's counsel essentially asked six times if Dr. Holberg was paid a rate other than $275 per hour, and in those six inquiries, Patent Owner's counsel made no mention of the related litigation. If Patent Owner's counsel wanted to ascertain if Dr. Holberg's rate was different for the related litigation preparation work, Patent Owner's counsel could have asked that question. In parity with this interpretation, just two days prior to the deposition in question, Dr. Holberg prepared a report that acknowledged he was compensated $400 per hour for trial preparation work. *See* Ex. 2031 ¶ 10 (Nov. 2, 2015); Ex. 2033, 1 (Nov. 4, 2015). It seems unlikely that Dr. Holberg would attempt to conceal a different compensation rate when it was acknowledged so close in time in another formal report. Further, Dr. Holberg's acknowledgment that he was paid at a rate other than $275 per hour for deposition work does not suggest any deceptive intent in the testimony relating to compensation. *See* Ex. 2033, 17:2–7. Indeed, even assuming the testimony is inconsistent, Patent Owner fails to provide any authority for why such an inconsistency results in giving no weight to the testimony.

Third, Patent Owner contends that Dr. Holberg admitted he did not draft his report. PO Resp. 49 (citing Ex. 2033, 16:9–12). We have no rule concerning how an expert report is drafted. Analogous Federal Rule of Civil Procedure 26(a)(2)(B) states an expert report must be "prepared and signed by the witness" but the advisory notes clarify that "does not preclude counsel from providing assistance to experts in preparing the reports, and indeed, . . . this assistance may be needed. Nevertheless, the report, which is intended to set forth the substance of the direct examination, should be written in a manner that reflects the testimony to be given by the witness and it must be signed by the witness." Fed.R.Civ.P. 26(a)(2)(B), advisory committee notes—1993 Amendment. Although Dr. Holberg stated that counsel drafted the report, this statement must also be considered in context. When preparing his report, Dr. Holberg performed the research that identified the majority of the material reviewed in preparation of the report, and further, Dr. Holberg reviewed the materials filed in this proceeding. Ex. 2033, 15:5–16:12. This is not a situation where counsel prepared the expert report in its entirety. *Cf. Numatics, Inc. v. Balluff, Inc.*, 66 F. Supp. 3d 934, 941 (E.D. Mich. 2014) ("An expert witness who is merely a party's lawyer's avatar contributes nothing useful to the decisional process."). This information does not cast sufficient doubt on the credibility of Dr. Holberg's testimony for it to affect the weight we accord that testimony.

For these reasons, we are not persuaded by Patent Owner's assertion that the whole of Dr. Holberg's declaration should be given little or no weight.

E. SCOPE AND INCORPORATION

Patent Owner requested authorization to file a Motion to Strike portions of Petitioner's Reply, alleging that portions exceeded the scope of Patent Owner's Response and improperly incorporated arguments. Paper 24 (transcript of call). We did not authorize a Motion to Strike; rather, we authorized Patent Owner to submit a paper in the form of a list "providing the location and a concise description of any portion of Petitioner's Reply" that Patent Owner alleges exceed the scope of Patent Owner's Response or improperly incorporates. Paper 26, 3–4 (order); Paper 27 (Patent Owner's submittal). We also authorized Petitioner to submit a response. Paper 28 (Petitioner's submittal).

Patent Owner's citation to Board determinations is argument and will not be considered. *See, e.g.*, Paper 27, 2–3 (citing *CaptionCall, LLC v. Ultratec, Inc.*, IPR2013-00549, slip op. at 5–6 (PTAB Dec. 1, 2015) (Paper 73)); Paper 26, 4 (prohibiting argument in the submittal); Paper 28, 1 (contending that Patent Owner's submittal improperly contains argument).

1. Balaban[8] and Associated Portions of Petitioner's Reply[9]

Patent Owner argues that Petitioner's citation of Balaban (Ex. 1053) is outside the permissible scope of a reply under 37 C.F.R. § 42.23(b). Paper 27, 1–2 (citing Pet. Reply 15 and noting that Balaban was not submitted with the Petition nor was it the basis of an instituted ground of unpatentability). Patent Owner contends that "Petitioner relies on Balaban

[8] Balaban is a cited reference of the '585 patent. Ex. 1001, (56).

[9] Pet. Reply 6 (top three lines), 14 (last three lines), 15 (top three lines).

to teach the 'detecting a carrier signal' claim element in the '585 patent." *Id.* at 1.

Patent Owner mischaracterizes Petitioner's contention. Petitioner does not rely on Balaban as disclosing a claim element; rather, Petitioner relies on Balaban as evidence of what is disclosed in Zenith. *See* Pet. Reply 15 *see generally Continental Can Co. U.S.A. v. Monsanto Co.*, 948 F.2d 1264, 1268–69 (Fed. Cir. 1991) (permitting recourse to extrinsic evidence regarding a characteristic the reference is silent on). Specifically, Petitioner contends that a synchronization signal as disclosed in Zenith is a carrier signal as illustrated by Balaban. *Id.* Further, we agree with Petitioner that use of Balaban is properly in response to an argument made by Patent Owner, namely, Patent Owner's argument that Petitioner has not explained how or why a "sync" signal could be a carrier signal. *See* Paper 28, 1–2; PO Resp. 41.

Consequently, Patent Owner has not demonstrated persuasively that reference to Balaban in this manner is prohibited by 37 C.F.R. § 42.23(b).

2. Carrier Signal[10]

Patent Owner argues that Petitioner's claim construction of the term "carrier signal" is not properly in response to an argument by Patent Owner, and should have been provided in the Petition. Paper 27, 2–3 (citing 37 C.F.R. §§ 42.23(b), 42.104(b)(3)). Based on this, Patent Owner asks that we consider neither the definition of a carrier signal found at Exhibit 1054 nor Petitioner's construction of the term. *Id.* at 2 (citing Pet. Reply 4).

[10] Specifically, Pet. Reply 4 (bottom paragraph)–6 (through section labeled "Carrier Signals"); Ex. 1061 ¶¶ 33–44; Ex. 1054 (entirety).

Patent Owner does not provide a claim construction for the term "carrier signal," nor does Patent Owner otherwise challenge the merits of Petitioner's assertion that a synchronization signal is a form of a carrier signal. We agree with Petitioner that Patent Owner's argument that Petitioner did not explain how a synchronization signal is a carrier signal opens the door regarding a proper interpretation of the claim term "carrier signal." *See* Paper 28, 2; PO Resp. 41.

Regarding Patent Owner's contention that "carrier signal" must have been construed in the Petition, although 37 C.F.R. § 42.104(b)(3) requires a petition to include a statement of how each challenged claim is to be construed, it is sufficient for a petition to state that a broadest reasonable interpretation applies. *See* Office Patent Trial Practice Guide, 77 Fed. Reg. at 48764 ("[I]t may be sufficient for a party to provide a simple statement that the claim terms are to be given their broadest reasonable interpretation, as understood by one of ordinary skill in the art and consistent with the disclosure."); Pet. 22 (asserting that the claims should be given the broadest reasonable construction, and that all terms carry their plain and ordinary meaning). Petitioner initially asserted that "carrier signal" carries its plain and ordinary meaning and now asserts that at the time of filing the '585 patent it was understood that a synchronization signal was a type of carrier signal. *See* Pet. 22; Pet. Reply 14–15. These assertions are consistent and do not represent a change in the ground of unpatentability.

Consequently, Patent Owner has not demonstrated that Petitioner's claim construction of the term "carrier signal" exceeds the scope of Patent Owner's Response or should have been provided in the Petition.

Patent Owner also contends that Petitioner improperly incorporates by reference by including one sentence in the Reply that does not include meaningful discussion of the three cited paragraphs of Dr. Holberg's Declaration. Paper 27, 2–3 (citing Pet. Reply 6 and Ex. 1061 ¶¶ 42–44); 37 C.F.R. § 42.6(a)(3).

Patent Owner's argument is unpersuasive for several reasons. First, 37 C.F.R. § 42.6(a)(3) prohibits incorporation of *arguments*, and an expert declaration, such as that at issue here, generally is considered *evidence*, not argument. To the extent that the cited portions of Dr. Holberg's Declaration can be considered argument, Patent Owner's analysis is incomplete in that Patent Owner only cites to 37 C.F.R. § 42.6(a)(3) and does not address the interplay with 37 C.F.R. § 42.24 (page limits). The Board often analyzes whether incorporation by reference is improper based on whether such incorporation would circumvent page limits.[11] *See, e.g.*, *Conopco, Inc. v. The Procter & Gamble Company*, IPR2013-00510, slip op. at 8 (PTAB Feb. 12, 2014) (Paper 9). Patent Owner makes no assertions regarding circumventing page limits. Petitioner's 16 page Reply is below the applicable limit of 25 pages.[12] 37 C.F.R. § 42.24(c)(1).

Third, contrary to Patent Owner's characterization, Petitioner provides a sufficient discussion of the cited portions of Dr. Holberg's Declaration (Ex.

[11] Under this rule, page limits for petitions were recently replaced by word limits. *See* 81 FR 24702, April 27, 2016, effective May 2, 2016.

[12] Petitioner's Reply was filed on February 12, 2016. Effective May 29, 2015, replies were limited to 25 pages. *See* 80 FR 28561; 37 C.F.R. § 42.24(c)(1).

1061). Specifically, Petitioner's explanation that Dr. Holberg's testimony is consistent with the plain and ordinary meaning of the term "carrier signal" is a sufficient explanation of the cited portions of the Declaration.

3. Select Signal[13]

Patent Owner contends that at page 4 of the Reply, Petitioner improperly incorporates paragraphs 14–32 of Exhibit 1061 when construing the term "select signal." Paper 27, 3–4. Patent Owner goes on to contend that Petitioner also improperly incorporates arguments in Dr. Holberg's Declaration that are not cited in the Reply. *Id.* at 3–4 (citing Ex. 1061 ¶¶ 15–21, 26, 28, 30).

As before, Patent Owner's argument is unpersuasive because 37 C.F.R. § 42.6(a)(3) prohibits incorporation of argument, not evidence.

Patent Owner's contention regarding portions of Dr. Holberg's Declaration that are not cited in the Reply is moot because we only consider those portions of the Declaration that are cited in the Reply. *See generally Cisco Systems, Inc. v. C-Cation Techs., LLC*, IPR2014-00454, slip op. 7–10 (PTAB Aug. 29, 2014) (Paper 12) (informative, expanded panel) (Information contained in exhibits or portions of exhibits, but not discussed in the Petition, is not incorporated into the Petition merely by the exhibits' presence in the record.).

[13] Pet. Reply 1 (bottom paragraph)–4 (middle paragraph); Ex. 1061 ¶¶ 14–32.

III. CLAIMED SUBJECT MATTER

A. INTRODUCTION TO THE SUBJECT MATTER

The '585 patent "relates to a broadband television signal receiver for receiving multi-standard analog television signals, digital television signals and data channels." Ex. 1001, 1:16–19. Figure 2 of the '585 patent is reproduced below.

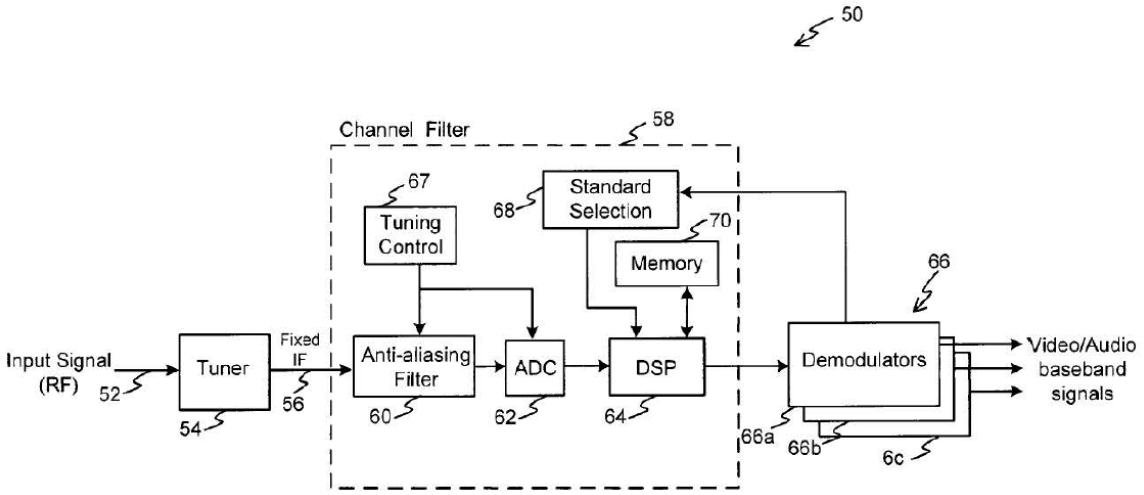

Figure 2 provides a block diagram of television receiver 50 that receives input radio frequency (RF) signals at input terminal 52. *Id.* at 1:52; 3:44–48. Tuner 54 converts an input RF signal to an intermediate frequency signal that is filtered and processed by anti-aliasing filter 60. *Id.* at 3:48–51; 4:3–7. The center frequency of anti-aliasing filter 60 is selected based on the intermediate frequency of the intermediate signal. *Id.* at 4:31–33. After filtering, the intermediate signal is sampled and digitized by analog-digital converter 62. *Id.* at 4:17–20. The resulting digital representation is processed by digital signal processor 64 "according to the television standard to which the input RF signal is encoded." *Id.* at 4:41–54. Specifically, the digital signal processor applies a filter function that depends on a manually or automatically established state of a standard selection

circuit used to select among "the several analog television standards and the several digital television standards." *Id.* at 4:55–64; 5:7–22. A bank of demodulators generates appropriate video and audio baseband signals from the digitally processed signals. *Id.* at 6:42–44.

B. ILLUSTRATIVE CLAIMS

Claims 1, 10, and 17 follow:

1. A receiver comprising:

> a tuner for receiving input RF signals and for converting said input RF signals to intermediate signals having an intermediate frequency (IF), said input RF signals encoding information in one of a plurality of formats; and
>
> a channel filter for receiving the intermediate signals, said channel filter comprising:
>
> an anti-aliasing filter for filtering said intermediate signals;
>
> an analog-to-digital converter for sampling said filtered intermediate signals and generating a digital representation thereof;
>
> a signal processor for processing said digital representation of said intermediate signals in accordance with said format of said input RF signal, said signal processor generating digital output signals indicative of information encoded in said input RF signal; and
>
> a plurality of demodulators, each coupled to receive output signals from said signal processor, each of said demodulators for demodulating said digital output signals according to one of said formats of said input RF signal, each of said demodulators generating video and audio baseband signals corresponding to said format of said input RF signal.

10. The receiver of claim 1, wherein said signal processor applies one of a plurality of finite impulse response filters to said

digital representation of said intermediate signal, each of said plurality of finite impulse response corresponding to a format of said input RF signal.

17. A method for receiving input RF signal[s] comprising:

receiving said input RF signals encoding information in one of a plurality of formats;

converting said input RF signals to intermediate signals having an intermediate frequency;

applying a first filter function to said intermediate signals, said first filter function being an anti-aliasing filter and having a center frequency;

digitizing said filtered intermediate signals at a sampling frequency;

processing said digitized signals in accordance with said format of said input RF signals and generating digital output signals indicative of information encoded in said input RF signals; and

demodulating using a plurality of demodulators said processed digitized signals to generate baseband signals corresponding to said format of said input RF signals.

Claims 11–15 depend, directly or indirectly, from claim 10, which depends from independent claim 1. Claim 20 depends indirectly from independent claim 17.

C. CLAIM CONSTRUCTION

1. Uncontested Interpretations

Patent Owner "applies the claim constructions provided by the Board in the Institution Decision." PO Resp. 6. We incorporate those constructions, and here repeat our conclusion, but not our analysis. In the interests of consistency, we identify applicable portions from the final decision the '728 IPR (Ex. 1062).

a) "input RF signals"

We interpreted that an "input RF signal" as recited in claims 1 and 17 is a signal that is input having a frequency between 10 kHz and 100 GHz. *See* Dec. 6–10; Ex. 1062, 6–8.

b) "tuner for receiving input RF signals"

We applied the plain and ordinary meaning to this phrase as recited in claim 1. Dec. 10.

c) "said input RF signals encoding information in one of a plurality of formats"

We interpreted that claims 1 and 17 require that each received input RF signal encodes information in exactly one format. Dec. 10–11; Ex. 1062, 8–9.

d) "processing said digital representation of said intermediate signals in accordance with said format"

We construed this claim phrase to require processing in accordance with the exactly one format in which each received input RF signal is encoded. Dec. 11–12; Ex. 1062, 9.

e) "receiver"

We determined that the term "receiver" as recited in claim 1, was not entitled to any patentable weight. Dec. 12–13; Ex. 1062, 10–11.

f) "video and audio baseband signals" and "baseband signals"

We construed "baseband signal" as a signal without transmission modulation. Dec. 13–14; Ex. 1062, 11–12.

g) "signal processor"

We construed a "signal processor" as recited in claim 1 refers to a digital module that processes signals in the digital domain. Dec. 14; Ex. 1062, 10

h) "indexes"

We construed that "indexes," as recited in claim 11, point to a block of memory when retrieving a set of coefficients of filter functions. Dec. 15.

2. Contested Claim Constructions

a) "select signal"

Claim 13 depends from claim 10, which depends in turn from claim 1, and recites, "wherein said channel filter further comprises a standard selection circuit coupled to said signal processor, said standard selection circuit generating a select signal indicative of a format of said input RF signal and said signal processor selecting a finite impulse response filter in response to said select signal."

Patent Owner contends that the broadest reasonable interpretation of this claim phrase is "a signal that performs a selection and that comprises information about the format of the input RF signal." PO Resp. 7. Patent Owner contends that the ordinary meaning of "indicative of" is "indicating information about." PO Resp. 7–8. This interpretation is based on "indicative" meaning "serving as a sign or indication (of)," and "indicate" meaning "to be a sign or token of." Ex. 2034-2.[14] Patent Owner adds that the phrase "indicative of" must have a different meaning from the claim term "in response to." PO Resp. 7.

Patent Owner's interpretation has several shortcomings. First, under Patent Owner's interpretation, the signal performs a selection, yet, claim 13 contains no such recitation. *See* Pet. Reply 4; Ex. 1061 ¶ 32. Although the signal is a "select signal," the language of claim 13 requires that the signal

[14] This Exhibit contains two pages marked 2034-1.

processor perform the selection of the FIR filter in response to the select signal.

Second, it is somewhat circular logic to contend that the claim term "indicative of" means "indicating information about," because the term "indicating" is a form of the word "indicative" (i.e., the word is used to define itself).

Third, claim 1 illustrates why Patent Owner's interpretation is incorrect. Claim 1 recites that the signal processor generates digital output signals "indicative of information" encoded in the input RF signal." If "indicative" means "indicating information about" as Patent Owner contends, then the term "information" in claim 1 would be redundant. *See Rexnord Corp. v. Laitram Corp.*, 274 F.3d 1336, 1342 (Fed. Cir. 2001) (a claim term should be construed consistently with its appearance in other claims of the same patent).

Fourth, Patent Owner fails to identify support for the term "information." Neither definition provided by Patent Owner recites the word "information." *See* PO Resp. 6–10; Ex. 2034, 2034-2. The definitions provided by Patent Owner suggest a different interpretation. An ordinary meaning of "indicate" is a "sign of." Ex. 2034, 2034-2. In the context of claim 13, this suggests that the select signal is "indicative of" the format of the input RF signal, in that the select signal provides a sign of the format of the RF input signal. The specification does not provide a lexicographical definition of "select signal." The term "select signal" is not explicitly found in the specification outside of the claims. Consistent with the interpretation that "indicative of" means "a sign of," the specification describes that standard selection circuit 68 can automatically select the correct standard

using a variety of techniques, to include by detecting the presence or absence of carrier signals.[15] Ex. 1001, 5:7–22; Figs. 1, 2.

Consequently, we agree with Petitioner that claim 13 requires that the select signal serves as a sign of a format of the input RF signal. *See* Pet. Reply 1–4.

b) "carrier signals"

Claims 15 and 20 each recite generating the select signal "by detecting carrier signals."

We agree with Petitioner's contention that the claim term "carrier signals" should be given its plain and ordinary meaning as reflected in the IEEE dictionary. Pet. Reply 4–6; Ex. 1061 ¶¶ 33, 40; *see also* Ex. 1054, 134.[16] That is, a carrier wave as recited is a wave having at least one characteristic that may be varied from a known reference value by modulation. We elaborate on this interpretation in Section IV.C., below.

[15] The interpretation that "indicative of" means a "sign of" has a different meaning than "in response to." *See* PO Resp. 7.

[16] This is the native page number of the Exhibit, which is the third page of the Exhibit.

IV. PATENTABILITY

A. INTRODUCTION

We instituted trial on the following grounds:

(1) claims 11 and 12 as unpatentable under 35 U.S.C. § 103(a) over Thomson,[17] Harris,[18] and Grumman[19];

(2) claims 13, 15, and 20 as unpatentable under 35 U.S.C. § 103(a) over Thomson, Harris, and Zenith[20]; and

(3) claim 14 as unpatentable under 35 U.S.C. § 103(a) over Thomson, Harris, Zenith, and Birleson.[21]

Dec. 25.

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art;

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[17] Ex. 1004, EP 0696854 A1, published Feb. 14, 1996.

[18] Ex. 1005, Harris, Clay Olmstead & Mike Petrowski, *A Digital Tuner for Wideband Receivers*, DSP APPLICATIONS MAGAZINE (1992).

[19] Ex. 1008, Grumman, US 5,381,357, Jan. 10, 1995. Petitioner identifies this reference by assignee rather than inventor; we do so as well for consistency.

[20] Ex. 1011, Zenith, US 6,377,316 B1, Apr. 23, 2002. Petitioner identifies this reference by assignee rather than inventor, and we do so as well for consistency.

[21] Ex. 1015, Birleson, US 6,725,463, B1 Apr. 20, 2004.

(2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness.[22] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

Arguments for patentability not raised in the Patent Owner response are waived. Paper 10, 3 ("The patent owner is cautioned that any arguments for patentability not raised in the response will be deemed waived.").

B. OBVIOUSNESS OVER THOMSON, HARRIS, AND GRUMMAN CLAIMS 11 AND 12

Claims 11 and 12 depend from claim 10, which depends in turn from independent claim 1. In the '728 IPR we determined that Petitioner demonstrated that claims 1 and 10 are unpatentable over Thomson and Harris. Ex. 1062, 14–29. Here, Petitioner relies upon the same showing with regard to the elements of claims 11 and 12 that are present by virtue of dependence from claims 1 and 10. *See* Pet. 38–43. We adopt or analysis from the '728 IPR here, and add the following regarding Petitioner's contention that the additional limitations of claim 11 and 12 would have been obvious over Thomson, Harris, and Grumman. Pet. 43–47.

1. Claim 11

a) Claimed Subject Matter and Ground

Claim 11 follows:

> 11. The receiver of claim 10, wherein said plurality of finite impulse response filters are stored in a memory, and said signal processor indexes said memory to retrieve one of said plurality of finite impulse response filters.[23]

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[22] The level of ordinary skill in the art was discussed earlier.

[23] The scope of this claim is similar to that of claim 24 of the '792 patent.

Petitioner explains that it was well-known to implement FIR filters by storing sets of FIR filter coefficients in memory and utilizing the signal processor to index those coefficients for retrieval, and details how Grumman discloses such a technique. Pet. 43–46; Ex. 1009 ¶¶ 62, 63. Specifically, Petitioner explains that Grumman discloses a two bank architecture (banks 0, 1) that allows the filter to operate with data in one bank while the other memory bank is updated with a new set of coefficients. Pet. 43–44; Ex 1009 ¶ 62; Ex. 1008, 11:25–29. Petitioner explicitly states that a set of coefficients corresponds to a FIR filter as claimed. Pet. 43. Petitioner reasons that a person of ordinary skill in the art would have incorporated Grumman's technique into the combination of Thomson and Harris, to provide easy and efficient access by a processor. Pet. 38–39; Ex. 1009 ¶ 58. That is, Petitioner proposes to modify the combination of Thomson and Harris so that Harris's FIR filter stores coefficient sets in memory and utilizes the signal processor to index those coefficients for retrieval as taught by Grumman. We agree with Petitioner.

b) Patent Owner Arguments

Patent Owner does not directly contest Petitioner's assertion that a set of coefficients corresponds to a FIR filter as claimed. *See* Pet. 43; PO Resp. 11–34. Rather, Patent Owner argues that Grumman discloses a single FIR filter having a real and an imaginary data portion that processes an incoming data signal (Yin(n)). PO Resp. 17–19; Ex. 1008, 5:33–41, 5:44–53; Figs. 1a, 1b, 3. In support, Dr. Opris opines that Grumman discloses a simple adaptive complex filter with a real and an imaginary portion that work simultaneously and in parallel. Ex. 2032 ¶ 98 (citing Ex. 1008, 7:32–35); PO Resp. 21.

We disagree with Patent Owner's framing of the dispositive issue as whether Grumman discloses a single two-part FIR filter or two FIR filters. Such a contention is not responsive to the ground of unpatentability as articulated by Petitioner. As detailed above, Petitioner proposes to modify the combination of Thomson and Harris so that Harris's FIR filters store sets of FIR filter coefficients in memory and so that Harris's signal processor indexes those coefficients for retrieval, as taught by Grumman. Pet. 43–46.

We disagree with Dr. Opris' characterization of Grumman. Grumman does not disclose two memory banks that "work simultaneously." *See* Ex. 2032 ¶ 98. Rather, as Petitioner correctly asserts, Grumman expressly discloses a filter that operates on the data (coefficient pair) in the first coefficient memory bank while the second bank is being updated with a new set of coefficients. *See* Ex. 1008, 11:25–29 ("[W]hile the filter is operating with data present in the first coefficient memory bank, the alternative memory bank, i.e., the one not being used by the filter, is being updated with the new set of coefficients."), Abstract ("While the coefficient data stored in the first and second memory storage circuits are being used by the adaptive weight circuits for processing thereof, the coefficient data values may be updated in the first alternate and second alternate memory storage banks and vice versa."); 4:7–9 (referring to coefficient data values stored in the memory banks); Ex. 1009 ¶ 62; Pet. Reply 6–8; Ex. 1061 ¶¶ 49, 54–61.

Patent Owner argues that Grumman does not disclose format-specific FIR filters as required by claim 11. PO Resp. 22; Ex. 2032 ¶ 99. The limitation at issue is present in claim 11 by virtue of dependence from claim 10. *See* Pet. Reply 9–19. Again, Patent Owner's argument is unpersuasive because it characterizes the ground of unpatentability as if Petitioner relies

upon Grumman alone when, as disclosed above, Petitioner relies upon Thomas and Harris for this limitation. *See* Pet. 38–43; Ex. 1062, 27–29.

Patent Owner argues that the Petition is "utterly silent" regarding the signal processor of the combination of Thomson, Harris, and Grumman. PO Resp. 27. According to Patent Owner, Petitioner's contention that Grumman's real and imaginary processing circuity correspond to a signal processor as claimed, reads the term "signal processor" out of claim 11. PO Resp. 24–25; Ex. 2032 ¶ 100. Patent Owner adds that Petitioner's expert, Dr. Holberg, agrees that Grumman does not disclose a signal processor as claimed. *Id.* (citing Ex. 2033, 75:9–10).

It is somewhat inconsistent for Patent Owner to contend that the Petition is "utterly silent" regarding the signal processor and also contend that the ground relies upon Grumman's real and imaginary processing circuity as corresponding to a signal processor as claimed. *See* PO Resp. 24–27. More importantly, Patent Owner characterizes the ground of unpatentability as if Petitioner relies only on Grumman for a "signal processor" as claimed. Such is not the case. The ground of unpatentability against claim 11 must be understood in the context that it builds upon the ground against claims 1 and 10. Petitioner relies on Thomson's adaptive bandpass filter as corresponding to the signal processor of claim 1. Pet. 38–41; *see also* Ex. 1062, 25–26 (relying on Thomson in the same manner). Petitioner proposes to modify Thomson in view of Harris to reach the subject matter of claim 10. *See* Pet. 41–43; *see also* Ex. 1062, 27–29. For claim 11, Petitioner explains why a person or ordinary skill would modify the combination of Thomson and Harris to store coefficient sets in memory and utilize the signal processor to index those coefficients for retrieval as

taught by Grumman. Pet. 45–47. Dr. Holdberg's testimony supports Petitioner's explanation. Specifically, Dr. Holberg testified that Grumman's signal processor is not by itself the signal processor of claim 11; rather, Grumman is relied on for the FIR filters that index memory to retrieve one of a plurality of FIR filters (from bank 0 or bank 1) to modify the combination of Thomson and Harris.[24] *See* Ex. 2033, 73:7–75:23. Petitioner mentions that Grumman includes a signal processor to illustrate how Grumman's technique is compatible with a signal processor. Pet. 45–46. Consequently, Patent Owner's argument is not persuasive.

Patent Owner argues that the references cannot be combined to render claim 11 obvious. PO Resp. 28–32. In particular, Patent Owner asserts that Petitioner has "not provided any reasons" for combining the references, and that Petitioner has not demonstrated a reasonable expectation of success. *Id.* at 28–29. Patent Owner contends that the ground of unpatentability is unclear and could mean one of two types of substitutions (i.e., that Grumman's FIR filter is substituted for all of Harris's FIR filters, or that Grumman's FIR filter is substituted for each of Harris's FIR filters). *Id.* at 29. For the reasons that follow, these arguments are not persuasive.

Patent Owner's contention that Petitioner has "not provided any reasons" is incorrect. As explained above, Petitioner reasons that a person of ordinary skill in the art would have incorporated Grumman's technique with Thomson and Harris, to provide easy and efficient access by a processor. *Id.* at 38–39; Ex. 1009 ¶ 58.

[24] Dr. Holberg refers to the ground of unpatentability of claim 10 of the '728 IPR, which is based upon Thomson and Harris.

Patent Owner's contention that Petitioner has not demonstrated a reasonable expectation of success is premised on the characterization that Grumman discloses a single FIR filter; however, as detailed above, that is not the proper focus of this inquiry.

Patent Owner's characterization that the ground of unpatentability is unclear and could mean one of two kinds of substitution is unpersuasive. Petitioner does not propose a substitution. Instead, as explained above, Petitioner proposes to modify the combination of Thomson and Harris so that Harris's FIR filter stores coefficient sets in memory and utilizes the signal processor to index those coefficients for retrieval as taught by Grumman.

c) Secondary Considerations

Patent Owner raises the secondary considerations of long-felt but unmet need, and industry praise. PO Resp. 49–50.

To be relevant, evidence of non-obviousness must be reasonably commensurate in scope with the claimed invention. *In re Huai-Hung Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011) (citing *In re Tiffin*, 448 F.2d 791, 792 (CCPA 1971); *In re Hiniker Co.*, 150 F.3d 1362, 1369 (Fed. Cir. 1998)). To be accorded substantial weight, there must be a nexus between the merits of the claimed invention and the evidence of secondary considerations. *In re GPAC*, 57 F.3d at 1580. "Nexus" is a legally and factually sufficient connection between the objective evidence and the claimed invention, such that the objective evidence should be considered in determining non-obviousness. *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). The burden of showing that there is a nexus lies with the patent owner. *Id.*

Patent Owner does not identify any particular claim, nor otherwise persuasively explain how these secondary considerations are commensurate in scope with the claimed invention. *See* PO Resp. 49–50.

(1) Long-felt but unmet need

Patent Owner contends that Petitioner tried and failed to develop its own digital tuner technology as evidenced by several patents, and contends that Petitioner introduced its first digital tuner in 2009, "somehow, just one year after seeing" Patent Owner's product.[25] PO Resp. 49 (citing several of Petitioner's patents filed as Exhibits 2014–2021 of the '728 IPR; Ex. 2036, 2). In support, Patent Owner's expert, Dr. Opris, opines that creating a universal receiver was a very complex task as evidenced by the fact that "no such product was created until after" Patent Owner's innovations. *Id.* at 49–50; Ex. 2003 ¶¶ 37–44.

Patent Owner did not file Exhibits 2014–2021 of the '728 IPR as exhibits in this proceeding, and for that reason we need not consider that evidence. Further, Patent Owner has not explained cogently how these patents illustrate a long-felt but unmet need. *See* PO Resp. 49–50. Even considering this evidence, it does not persuasively support Patent Owner's contention. The '585 patent claims priority to a provisional application that was filed on September 17, 2001, and the oldest of Petitioner's patents cited by Patent Owner came after the '585 patent, and thus cannot be evidence of

[25] To the extent that Patent Owner's assertion suggests copying by Petitioner, such a contention is not persuasive. For example, Patent Owner presents no argument or evidence that Petitioner's product is substantially identical to the claimed product, or that Petitioner expended great effort to develop its own solution, but failed.

a need that existed prior to the '585 patent. *See* Ex. 1001, (60); Ex. 2014 of the '728 IPR (filed on February 28, 2003).

Even accepting as true that development of the claimed subject matter was difficult, as Dr. Opris contends, such contention does not demonstrate an art-recognized problem existed for a long period of time without solution. *See* Ex. 2003 ¶¶ 37–44. Nor does this evidence demonstrate that others expended substantial effort and resources in an attempt to solve the problem.[26] *Id.*

Consequently, Patent Owner has not demonstrated effectively that an art-recognized problem existed for a long period of time without solution. *See Newell Cos. v. Kenney Mfg. Co.*, 864 F. 2d 757, 768 (Fed. Cir. 1988); *see also In re Gershon*, 372 F.2d 535, 538–39 (CCPA 1967) (the evidence must show that the need was a persistent one that was recognized by those of ordinary skill in the art).

Patent Owner's contention that Petitioner introduced its first digital tuner in 2009, "somehow, just one year after seeing" Patent Owner's product, implies copying. "[C]opying by a competitor may be a relevant consideration in the secondary factor analysis." *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1325 (Fed. Cir. 2004) (citing *Vandenberg v. Dairy Equip. Co.*, 740 F.2d 1560, 1567 (Fed. Cir. 1984)). "[A] nexus between the copying and the novel aspects of the claimed invention must exist for evidence of copying to be given significant weight in an

[26] We note that paragraphs 37–44 of Dr. Opris' second declaration (Ex. 2033) also address the difficulties of developing the claimed subject matter. Although not cited in Petitioner's Response. As evidence of secondary considerations, this information suffers from the same shortcomings as the cited portion of his first declaration (Ex. 2003).

obviousness analysis." *Wm. Wrigley Jr. Co. v. Cadbury Adams USA LLC*, 683 F.3d 1356, 1364 (Fed. Cir. 2012) (internal quotation omitted). "[M]ore than the mere fact of copying by an accused infringer is needed to make that action significant to a determination of the obviousness issue." *Cable Elec. Products, Inc. v. Genmark, Inc.*, 770 F.2d 1015, 1028 (Fed. Cir. 1985). *Accord Vandenberg*, 740 F.2d at 1567 (finding that where copying of a patented device, despite the failure of protracted efforts by the copyist to design a similar device, was an admission of the mechanical superiority of the patented version, but "not strong evidence of nonobviousness.").

Patent Owner's copying contention is unpersuasive for two reasons. First, Patent Owner provides no evidence of when Petitioner began development efforts. Second, Patent Owner does not explain or provide evidence demonstrating that Petitioner's tuner is substantially identical to the claimed product or that Petitioner expended great effort but failed to develop its own solution. *See Pentec, Inc. v. Graphic Controls Corp.*, 776 F.2d 309 (Fed. Cir. 1985).

(2) Industry Praise

Patent Owner contends that the 2008 ECN Reader's Choice Tech Award won by Patent Owner's subsidiary, Xceive Corporation, demonstrates industry praise.[27] PO Resp. 50 (citing Ex. 2037, 1).

Industry praise for an invention may provide evidence of non-obviousness where the industry praise is linked to the claimed invention. *See, e.g., Geo. M. Martin Co. v. Alliance Mach. Sys. Int'l LLC*, 618 F.3d

[27] ECN stands for Electronic Component News. Ex. 2037, 11.

1294, 1305 (Fed. Cir. 2010); *Asyst Techs., Inc. v. Emtrak, Inc.*, 544 F.3d 1310, 1316 (Fed. Cir. 2008).

Exhibit 2037 appears to be a magazine page dated December 15, 2008, captioned "ECN 2008 Readers Choice TECH AWARDS," "Boards, Modules & Embedded Systems • TOP FIVE," and includes the following relevant article:

> **Module Aids in TV Tuner Architecture Conversion**
>
> Exceeding ATSC, OpenCable, DVBT/C/H, DMB-TH, and ISDB-T standards, Xceive Corporation's SN5000A SiliconNOW tuner module helps bridge the gap between CAN tuner architecture and silicon-based TV tuner architecture. The component offers plug-and-play physical compatibility with specific CAN tuners, Xceive's XC5000 silicon tuner, and integrated programmable DSP to optimize hardware. The 50-mm x 27-mm module exhibits a two-in-one CAN-replacement supporting onboard demodulation of NTSC, PAL, and SECAM TV standards. The unit comes with Xceive's QuickTune technology for a complete channel scan of more than 100 channels in less than five seconds. Another available offering includes ChannelVista, Xceive's picture-in-picture (PIP) television technology, allowing the viewer to watch up to 12 video channels simultaneously with a single tuner. The module presents RF input, CVBS output, and SIF output impedances of 75 Ω, and VSWR of 2:1 in frequencies from 42 MHz to 864 MHz while operating from a 5-V power supply. **Xceive Corporation, 408-486-5610, www.xceive.com**[28]

Ex. 2037, 1.

Patent Owner provides no argument or evidence regarding the prestige of this award in the industry. Patent Owner does not identify a single feature mentioned in the award that corresponds to a limitation of any of the claims

[28] Formatting here differs from the Exhibit.

of the ’585 patent. The article mentions several features of the Xceive module that are not found in the challenged claims, such as: exceeding ATSC, OPENCable, DVBT/C/H, DMB-TH, and ISDB-T standards; “plug-and-play physical compatibility;” support for NTSC, PAL, and SECAM TV standards; the ability to scan 100 channels in under five seconds; picture in picture technology, and operating from a 5 volt power supply. Consequently, Patent Owner has not demonstrated persuasively that the praise is attributable to claimed features. *See Power-One, Inc. v. Artesyn Techs., Inc.*, 599 F.3d 1343, 1352 (Fed. Cir. 2010) (praise specifically related to features of the patented invention is probative of the nonobviousness of an invention); *cf. PPC Broadband, Inc. v. Corning Optical Communications RF, LLC*, 815 F.3d 734, 746–47 (Fed. Cir. 2016) (reversing the Board’s finding of no commercial success where the Patent Owner presented undisputed evidence that the successful product was the claimed product).

(3) Summary of Secondary Considerations

Patent Owner provides some evidence of a need at the time of invention, but does not show persuasively that an art-recognized problem existed for a long period of time without solution. Nor has Patent Owner demonstrated a connection between the evidence and claimed invention. Patent Owner’s implied assertion of copying is unpersuasive, and Patent Owner has not shown that the evidence of praise for Xceive’s tuner is tied to claimed features. Patent Owner’s evidence of secondary considerations does little or nothing to demonstrate the nonobviousness of the claimed subject matter.

d) Conclusion

We have considered the entirety of the evidence, including the evidence of secondary considerations. The weak evidence of secondary considerations does not outweigh the strong case for obviousness of claim 11 outlined above. We conclude that Petitioner has demonstrated by a preponderance of the evidence that claim 11 is unpatentable for obviousness under 35 U.S.C. § 103(a) over Thomson, Harris, and Grumman.

2. Claim 12

a) Claimed Subject Matter and Ground

Claim 12 follows:

> 12. The receiver of claim 10, wherein said signal processor comprises a first computing unit and a second computing unit, said first computing unit processing a real part of said finite impulse response filter operation while said second computing unit processing an imaginary part of said finite impulse response filter operation.

Petitioner contends that Grumman discloses a first and a second computing unit (circuits 17, 16), wherein the first computing unit processes a real part of the FIR filter operation (circuit 17) while the second computing unit processes the imaginary portion of the FIR filter operation (circuit 16). Pet. 47–50; Ex. 1008, 2:63–3:2, 3:36–39, 3:41–44; 7:32–35, Fig. 2; Ex. 1009 ¶¶ 65–68. Petitioner reasons that a person of ordinary skill in the art would have made the proposed modification because Grumman's architecture is very efficient, especially in the context of minimizing any delays caused by selecting a different set of FIR filter coefficients by indexing memory. Pet. 49 (citing Ex. 1009 ¶ 68; Ex. 1008, claims 10, 11). We agree with these contentions.

b) Patent Owner Arguments

Patent Owner contends that the Petition relies solely on Grumman for the limitation of claim 12, and is silent regarding any role of Harris in the combination. PO Resp. 32 (citing Pet. 47–50), 34–35. To the extent that Patent Owner is contending that Harris plays no role in this ground of unpatentability, we disagree. Petitioner explains that claim 12 depends from claim 10 which depends in turn from claim 1, and for that reason even though claims 1 and 10 are not challenged in this Petition, Petitioner addresses the limitations of these claims. *See* Pet. 30–31, 38–43. In particular, the ground of unpatentability for claim 10 relies upon, and defines the role of Harris. *Id.* at 41–43. Consequently, the ground of unpatentability for claim 12 relies upon Grumman to further modify the combination of Thomson and Harris asserted against claim 10.

Patent Owner argues that Petitioner's proffered reason of "efficiency" does not explain adequately why a person of ordinary skill in the art would combine these references when the complex Grumman filter is not needed. PO Resp. 33. In particular, Patent Owner contends that the modification would add additional cost and complexity, and contends that Petitioner has not explained adequately how the benefit of efficiency is provided by Grumman's separate real and imaginary computing units. *Id.* at 33–34.

As noted above, Petitioner explains that Grumman improves the efficiency of the combination of Thomson and Harris because Grumman's architecture is efficient in that it minimizes delays caused by selecting a different set of FIR filter coefficients by indexing memory. Pet. 49 (citing Ex. 1009 ¶ 68); *see also* Pet. Reply 12 (citing Ex. 1061 ¶¶ 72–75). As explained in the analysis of claim 11 above, Grumman expressly discloses a

filter that operates on the data in the first coefficient memory bank while the second bank is being updated with a new set of coefficients. For that reason, Petitioner's reasoning is based upon a rational underpinning. Patent Owner's conclusory assertion that Grumman's filter is complex and not needed does not persuade us otherwise.

c) Conclusion

We have considered the entirety of the evidence, including the evidence of secondary considerations. We conclude that Petitioner has demonstrated by a preponderance of the evidence that claim 12 is unpatentable for obviousness under 35 U.S.C. § 103(a) over Thomson, Harris, and Grumman.

C. OBVIOUSNESS OVER THOMSON, HARRIS, AND ZENITH CLAIMS 13, 15, AND 20

1. Claim 13

a) Claimed Subject Matter and Ground

Claim 13 follows:

> 13. The receiver of claim 10, wherein said channel filter further comprises a standard selection circuit coupled to said signal processor, said standard selection circuit generating a select signal indicative of a format of said input RF signal and said signal processor selecting a finite impulse response filter in response to said select signal.[29]

Regarding selecting a FIR filter in response to the select signal, Petitioner relies upon the combination of Thomson and Harris discussed with regard to claim 10, further modified to include a selection signal as

[29] Claim 10 depends from independent claim 1.

disclosed by Zenith. *See* Pet. 52–54; Ex. 1009 ¶ 74. Petitioner contends that the standard selection input of Thomson's signal processor suggests to a person of ordinary skill in the art that a circuit should be used to generate a standard selection signal. Pet. 50; Ex. 1009 ¶ 69. For the reasons that follow, we agree with Petitioner.

Thomson's signal processor includes an adaptive filter 8 that selects based on TV standard, and therefore discloses a standard selection input. *See* Pet. 39–40; Ex. 1004, 3:16–19, Fig. 1; Ex. 1009 ¶ 57. Dr. Holberg explains that this disclosure suggests to a person of ordinary skill in the art that a circuit should be used to generate a standard selection signal. Ex. 1009 ¶ 69.Zenith discloses a television receiver that includes a tuner for receiving either analog or digital signals. Ex. 1011, 1:8–10; Pet. 50. Zenith's microprocessor selectively couples the tuner to either the analog or digital demodulator based upon the type of signal (analog or digital) received device. Ex. 1011, 3:13–15, Figs. 1–3[30]; Pet. 50–51; Ex. 1009 ¶¶ 70–71. For example, in the embodiment shown in Figure 1 when sync signals are present, microprocessor 22 causes switch 14 to route the IF signal from tuner 12 to analog demodulator 16, and when sync signals are not present, microprocessor 22 causes switch 14 to route the IF signal to digital demodulator 18.[31] Ex. 1011, 2:38–45, Fig. 1; Pet. 51. Therefore, the sync

[30] Figures 1 and 2 are the invention of prior applications and Figure 3 is the invention of Zenith. Ex. 1011, 2:6–13, 2:18–23.

[31] Petitioner uses the description of the operation of the Figure 2 embodiment in association with the Figure 1 embodiment. *See* Pet. 51. This oversight is of no consequence because the operation of the Figure 2 embodiment is the same as that of Figure 1. *See* Ex. 1011, 3:13–15.

signals result in identification of a specific television standard. Ex. 1009 ¶ 71.

b) Patent Owner Arguments

Patent Owner argues that neither Zenith, nor the combination as a whole, discloses a select signal indicative of a format of an input RF signal as claimed. PO Resp. 35–38. Specifically, Patent Owner contends that Zenith's microprocessor does not generate a select signal indicative of a format of an input RF signal as claimed, in that the signal does not contain information. *Id.* at 36–38 (Ex. 2032 ¶¶ 79–88, 91–94). Patent Owner's argument is unpersuasive because it is not commensurate in scope with claim 13. Although not explicit, Dr. Opris' assertion that a one-bit signal, such as disclosed by Zenith, "is not indicative of a format," is based on the same improper claim interpretation. *See* Ex. 2032 ¶ 83. As detailed in our claim construction above, the select signal need only serve as a sign of a format of the input RF signal. Consequently, we agree with Petitioner that a single bit such as Zenith's provides an indication (sign) of one of the plurality of formats. Pet. Reply 12–13; Ex. 1061 ¶¶ 79–80; Ex. 1011, 5:22–23; *see also* Ex. 1001, 5:12–15 (describing that the preferred embodiment of the '585 patent that detects the presence of absence of carrier signals, just as Zenith detects the presence of absence of sync signals).

Patent Owner argues that Petitioner has not provided a sufficient reason for combining the references. PO Resp. 38. This conclusory assertion is unpersuasive because it does not address the reason provided by petitioner. As detailed above, Petitioner contends, and we agree, that the standard selection input of Thomson's signal processor suggests to a person

of ordinary skill in the art that a circuit should be used to generate a standard selection signal. Pet. 50; Ex. 1009 ¶ 69.

Patent Owner argues that none of the references, taken individually, disclose the selection of a FIR filter or a signal processor as claimed. PO Resp. 38–40. This contention is unpersuasive because, rather than addressing the combination of references as articulated by Petitioner, Patent Owner attacks the references individually. *See* Pet. 38–43. Further, these limitations are present in claim 13 by virtue of dependence from claim 10, and we have already determined that the subject matter of claim 10 is obvious over Thomson and Harris. *See* Ex. 1062, 27–29.

c) Conclusion

Patent Owner's weak evidence of secondary considerations does not outweigh the strong case for obviousness of claim 13 as outlined above. We conclude that Petitioner has demonstrated by a preponderance of the evidence that claim 13 is unpatentable for obviousness under 35 U.S.C. § 103(a) over Thomson, Harris, Grumman, and Zenith.

2. Claims 15 and 20

a) Claimed Subject Matter and Ground

Claim 15[32] follows:

> 15. The receiver of claim 13, wherein said standard selection circuit generates said select signal by detecting carrier signals identifying one of said formats of said input RF signals.

Claim 20[33] follows:

[32] Claim 13 depends from claim 10 which depends in turn from independent claim 1.

[33] Claim 19 depends from independent claim 17.

> 20. The method of claim 19, further comprising: generating said select signal by detecting carrier signals in said input RF signal identifying said format of said input RF signal.

Claims 15 and 20 are more specific than claim 13 in that the format of the input RF signals must be determined by detecting a carrier signal.

Petitioner contends that Zenith's sync separator 20 and microprocessor 22 detect sync signals, which are carrier signals.[34] Pet. 55–56 (citing Ex. 1001, 3:15–18, 5:12–15; Ex. 1009 ¶¶ 77, 80–86). In support, Dr. Holberg states that "by identifying syncs in the demodulated analog signal, Zenith identifies carrier signals in the input RF signal." Ex. 1009 ¶ 77 (citing Ex. 1011, 3:15–18). Petitioner asserts that Balaban, "expressly teaches that '***detecting a carrier signal includes detecting*** at least one of a picture carrier, a sound carrier, and ***a synchronization signal***.'"[35] Pet. Reply 14–15 (citing Ex. 1053, 19:18–20 (claim 31)). Indeed, claim 31 of Balaban is a method of receiving a television signal that may be in analog or digital signal format, wherein detecting a signal characteristic unique to the analog signal format includes detecting a carrier signal, and detecting the carrier signal includes at least one of detecting: a picture carrier, a sound carrier, and a synchronization signal.[36] Ex. 1053, 18:65–19:20. Balaban is evidence that a synchronization signal is a type of carrier signal.

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[34] Zenith refers to element 20 as "sync separator" and "SYNC DET." *See, e.g.*, Ex. 1011, 2:34, Figs. 1–3.

[35] As detailed above, Petitioner reliance on Balaban is not improper under 37 C.F.R. § 42.23(b).

[36] Claim 31 depends from claim 30 which depends in turn from claim 29.

b) Patent Owner Arguments

Patent Owner argues that Zenith does not disclose that a sync signal is a carrier signal. PO Resp. 41. We agree that Zenith does not explicitly disclose that a sync signal is a type of carrier signal; however that does not end our inquiry.

According to Patent Owner, a demodulated analog signal does not contain a carrier signal, and Petitioner's expert acknowledged as much. *Id.* at 42–43 (referring to Dr. Holberg's testimony (Ex. 2033, 50:9–51:1, 52:14–21, 125:7–126:25)); Ex. 2032 ¶¶ 93–94.

We disagree with Patent Owner's characterization of Dr. Holberg's testimony. In the referenced Deposition, during cross-examination, Dr. Holberg stated that a carrier signal is a signal that carries the modulation during transmission. Ex. 2033, 49:12–50:14. Dr. Holberg also stated that the output of an analog demodulator does not include transmission modulation. *Id.* at 50:23–51:1. Dr. Holberg did not state that demodulation removes the carrier signal.

Later during that Deposition, on redirect, the questioner asked Dr. Holberg whether the output of Zenith's analog demodulator contains a carrier signal. Ex. 2033, 125:7–126:5. Dr. Holberg indicated that the answer was in either the '792 or the '585 patent. *Id.* at 126:8–12. The questioner directed Dr. Holberg's attention to column five, line 12 of the '585 patent. *Id.* at 126:13–17. Dr. Holberg read that section and opined that this portion of the '585 patent is not referring to a transmission carrier, but is referring to carrying the sync signals in the form of video signals. *Id.* at 126:18–25. Turning then to Figure 2 of the '585 patent, Dr. Holberg stated that standard selection circuit 68 was downstream (received the output signal

of) the demodulators. *Id.* at 126:1–14. Dr. Holberg indicated that this aspect of the '585 patent informed his opinion regarding operation of Zenith's sync detector 20 detects carrier signals as claimed.[37] In other words, Dr. Holberg explained that the standard selection circuit of the '585 patent detects carrier signals downstream of a demodulator. Consequently, we are not persuaded by Patent Owner's assertion that demodulators remove the carrier signal.[38]

c) Conclusion

Patent Owner's weak evidence of secondary considerations does not outweigh the strong case for obviousness of claims 15 and 20. We conclude that Petitioner has demonstrated by a preponderance of the evidence that claims 15 and 20 are unpatentable for obviousness under 35 U.S.C. § 103(a) over Thomason, Harris, Grumman, and Zenith.

D. OBVIOUSNESS OVER THOMASON, HARRIS, ZENITH, AND BIRLESON CLAIM 14

1. Claimed Subject Matter and Ground

Claim 14 follows:

> 14. The receiver of claim 13, wherein said standard selection circuit generates said select signal in response to an input signal from a user.

PO Resp. 44–47.

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[37] Although the questioner referred to Dr. Holberg's opinion regarding claim 28 of the '792 patent, this information is applicable because claim 28 of the '792 patent is similar in scope to claims 15 and 20 of the '585 patent.

[38] Patent Owner's assertion that Zenith's microprocessor 22 only samples the output of analog demodulator 16 and is unsuited for carrier detection is unpersuasive for similar reasons. *See* PO Resp. 44; Ex. 2032 ¶ 94.

Petitioner contends that it was well-known to utilize "user selection" for control of a television. Pet. 56–57. Petitioner relies upon Birleson (Ex. 1015) as disclosing a standard selection circuit as claimed. *Id.* Petitioner concludes that it would have been obvious to generate the select signal of Thomson in response to the most common type of input (user selection) and such a choice would have been obvious to try as such input is one of a finite set of inputs that could be used. *Id.* at 58–59. We agree with these contentions.

Birleson discloses a dual mode tuner for co-existing digital and analog television signals that includes an automatic carrier detection (ACD) circuit that monitors the output of two second intermediate frequency filters to determine whether the signal being processed in digital or analog format. Ex. 1015, (54), 1:18–20, 2:50–59, 10:52–11:19. Birleson's ACD circuit 30 can also operate in a signal test mode. *Id.* at 11:20–38; Figs. 1, 3. For example, signal testing may be initiated by a channel change or input change by a user, causing the selection circuit to generate a select signal. *Id.*

2. Patent Owner Arguments

The parties do not disagree on operation of Birleson's selection circuit; the focus of the dispute is whether signal testing as disclosed by Birleson corresponds to generating a select signal as claimed. *See* PO Resp. 44–47; Pet. Reply 15. Patent Owner contends that the '585 patent distinguishes manual (claim 14) from automatic (claim 15) selection. PO Resp. 45–46 (citing Ex. 1001, 5:7–12). According to Patent Owner, a user can initiate signal testing in Birleson's device, but signal testing is not generating a select signal in response to an input signal from a user as required by claim 14. PO Resp. 46–47 (citing Ex. 2032 ¶¶ 110–114).

Dr. Opris opines that a user initiated channel or input change is not sending an "input signal" as claimed. Ex. 2032 ¶¶ 110–113. For the reasons that follow, we agree with Petitioner that Patent Owner's argument is unpersuasive because it is not commensurate in scope with claim 14.

The word "manual" is not found in claim 14.[39] Nor does the claim recite that the input signal must directly (with no intervening action) cause generation of the select signal. Instead, claim 14 recites that the selection circuit generates the select signal "in response to" an input signal from the user.

The specification describes that the selection of the correct standard can be made "manually by the user of the television system, such as by activating a switch, or the selection can be made automatically by providing an auto-detection capability in TV receiver 50." Ex. 1001, 5:7–12. This description of an example is not a lexicographical definition and does not provide a basis for reading the term "manual" into claim 14. Nor does this description state that the input signal from the user must directly cause generation of the select signal.

Claim 14 requires that the standard selection circuit generates a select signal in response to input from the user. Claim 14 does not require that the select signal is manually generated nor that the user input signal directly causes generation of the select signal. Birleson's signal testing technique can be initiated by a user's channel or input change, and that user action triggers generation of a select signal. Consequently, the select signal is "in response to" the user's input signal as required by claim 14.

[39] Nor is the term "automatically" found in claim 15.

3. Conclusion

Patent Owner's weak evidence of secondary considerations does not outweigh the strong case for obviousness of claim 14. We conclude that Petitioner has demonstrated by a preponderance of the evidence that claim 14 is unpatentable for obviousness under 35 U.S.C. § 103(a) over Thomason, Harris, Grumman, Zenith, and Birleson.

V. ORDER

For the reasons given, it is:

ORDERED that claims 11 and 12 have been shown by a preponderance of the evidence to be unpatentable as obvious over Thomson, Harris, and Grumman;

FURTHER ORDERED that claims 13, 15, and 20 have been shown by a preponderance of the evidence to be unpatentable as obvious over Thomson, Harris, and Zenith;

FURTHER ORDERED that claim 14 has been shown by a preponderance of the evidence to be unpatentable as obvious over Thomson, Harris, Zenith, and Birleson;

FURTHER ORDERED that Petitioner's Motion to Exclude is denied; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IPR2015-00615
Patent 7,075,585 B2

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(12) **United States Patent**
Favrat et al.

(10) **Patent No.: US 7,075,585 B2**
(45) **Date of Patent: Jul. 11, 2006**

(54) **BROADBAND RECEIVER HAVING A MULTISTANDARD CHANNEL FILTER**

(75) Inventors: **Pierre Favrat**, Sunnyvale, CA (US); **Didier Margairaz**, Saratoga, CA (US); **Alain-Serge Porret**, Sunnyvale, CA (US); **Dominique Python**, Sunnyvale, CA (US)

(73) Assignee: **Xceive Corporation**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 592 days.

(21) Appl. No.: **10/236,645**

(22) Filed: **Sep. 6, 2002**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 60/322,548, filed on Sep. 17, 2001.

(51) **Int. Cl.**
H04N 3/27 (2006.01)
H04N 5/455 (2006.01)

(52) **U.S. Cl.** **348/554**; 348/726; 348/725; 375/340; 455/189.1

(58) **Field of Classification Search** 348/554, 348/555, 558, 725, 726; 375/316, 340, 343; 455/189.1, 245.2, 179.1, 188.1, 192.1, 334
See application file for complete search history.

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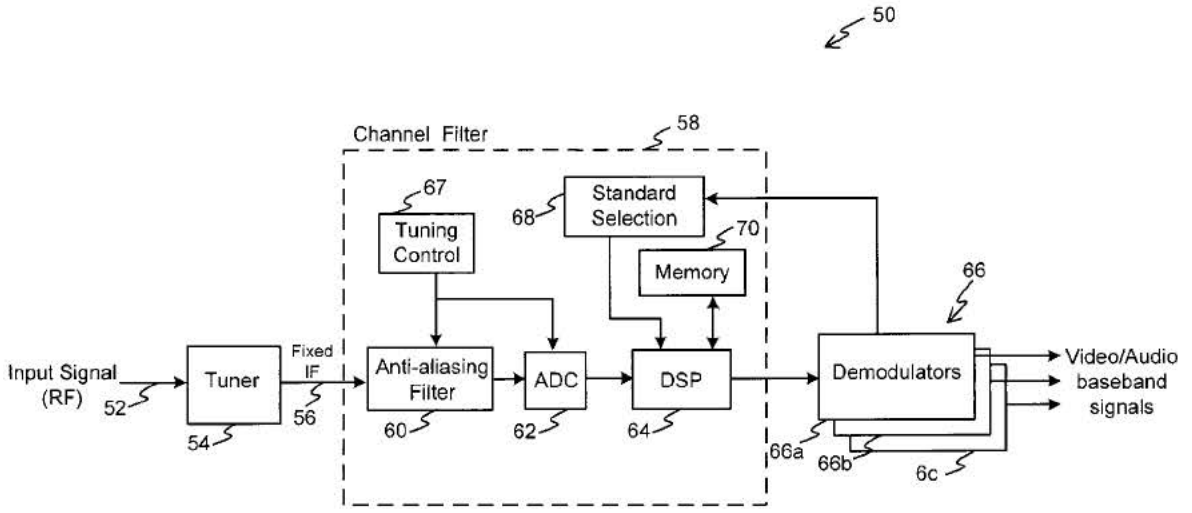
(57) **ABSTRACT**

A television (TV) receiver includes a multi-standard channel filter with a programmable intermediate frequency adapted to receive television signals in a variety of television standards and formats. In one embodiment, a receiver includes a tuner and a channel filter. The tuner receives input RF signals encoding information in one of a number of formats and converts the input RF signals to intermediate signals having an intermediate frequency (IF). The intermediate signals are coupled to the channel filter. The channel filter includes an anti-aliasing filter for filtering the intermediate signals, an analog-to-digital converter for sampling the filtered intermediate signals and generating a digital representation thereof, and a signal processor for processing the digital representation of the intermediate signals in accordance with the format of the input RF signal. The signal processor generates digital output signals indicative of information encoded in the input RF signal.

21 Claims, 5 Drawing Sheets



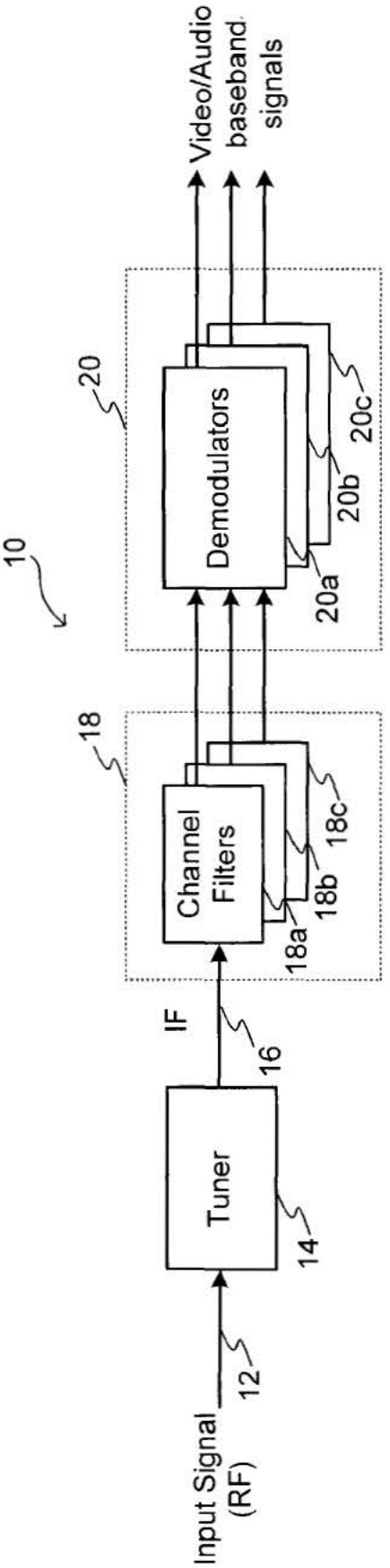


Figure 1 (Prior Art)

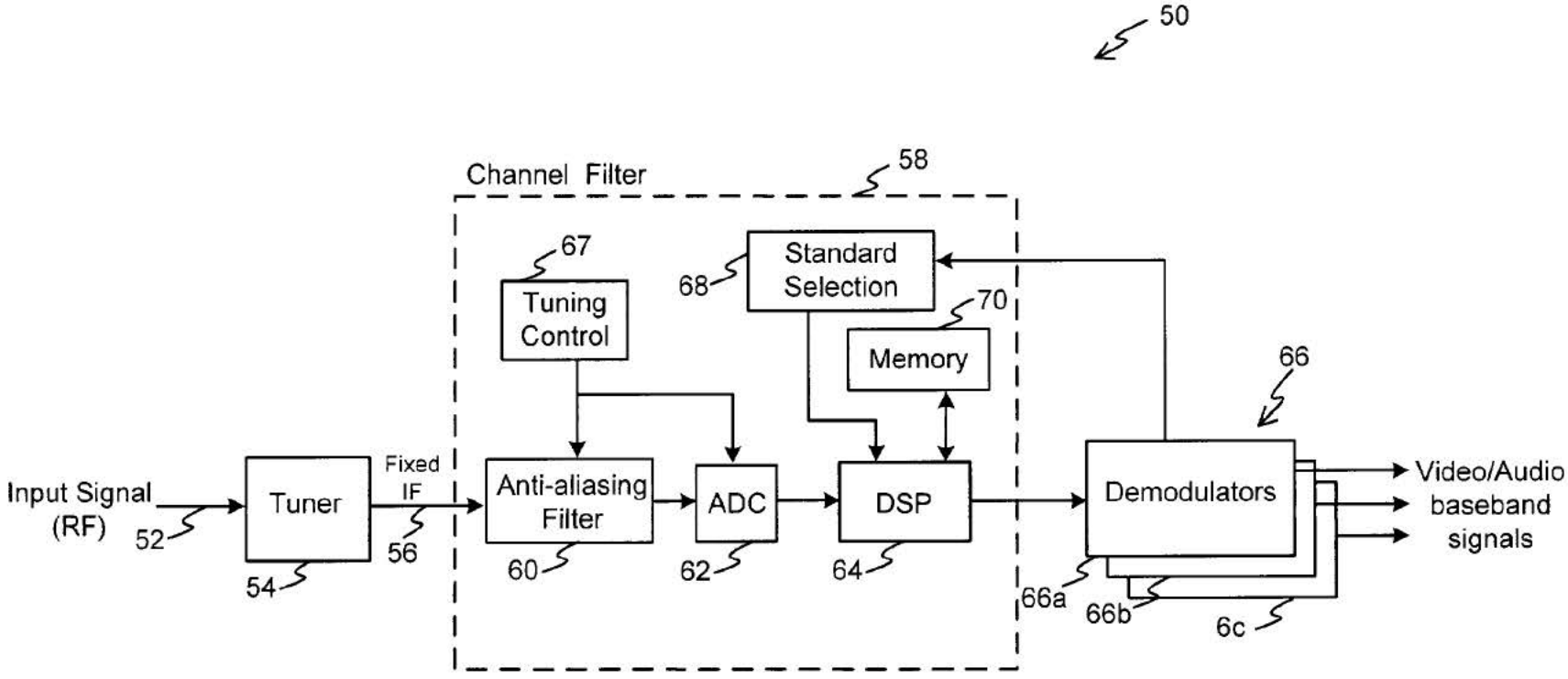

50
Channel Filter
58
67
Tuning Control
68
Standard Selection
70
Memory
66
Input Signal (RF)
52
Tuner
54
Fixed IF
56
Anti-aliasing Filter
60
ADC
62
DSP
64
Demodulators
66a
66b
6c
Video/Audio baseband signals

Figure 2

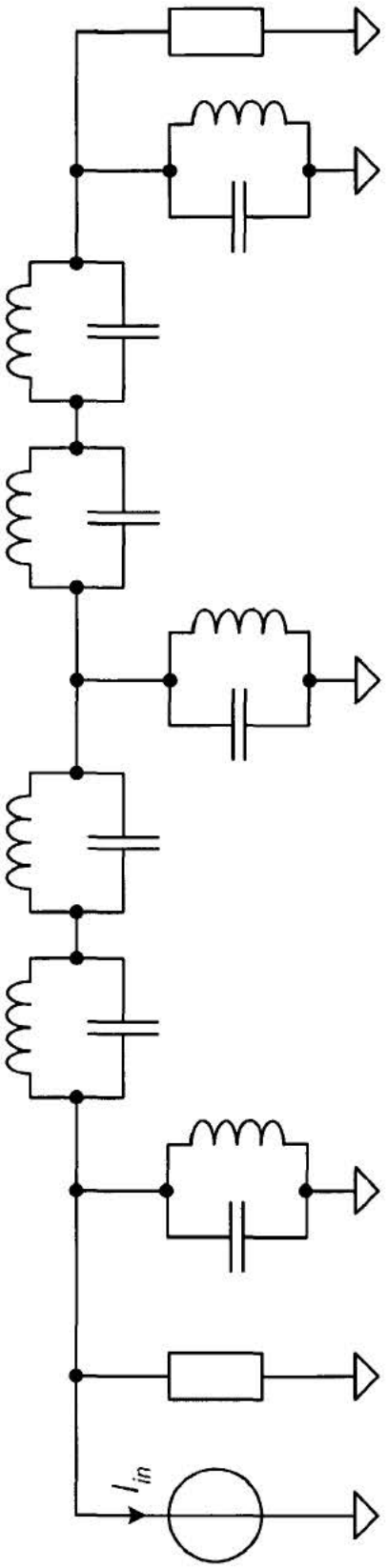
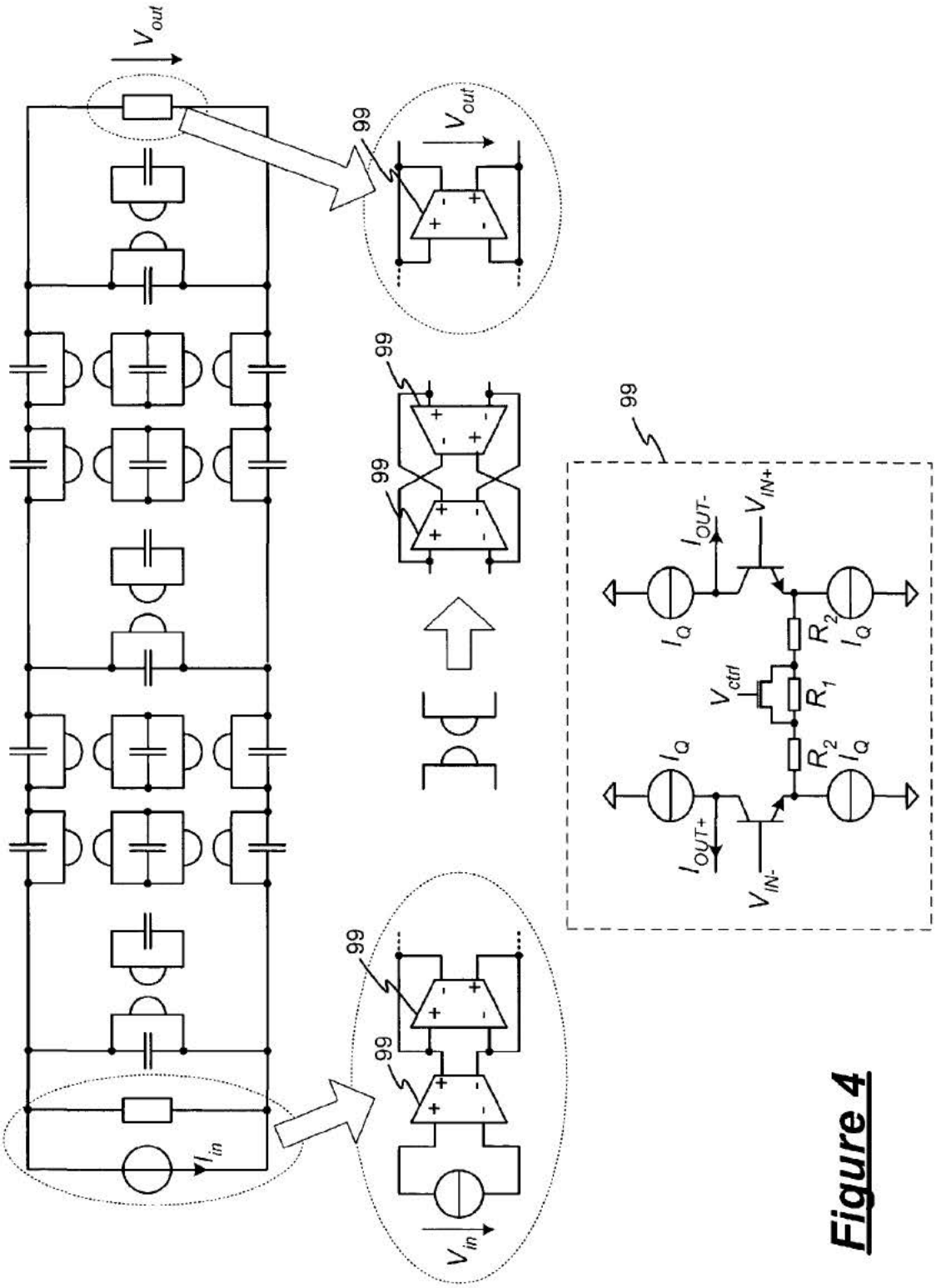


Figure 3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V_{out}
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R_2
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R_1
I_Q
R_2
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V_{IN-}
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99
99
V_{in}

Figure 4

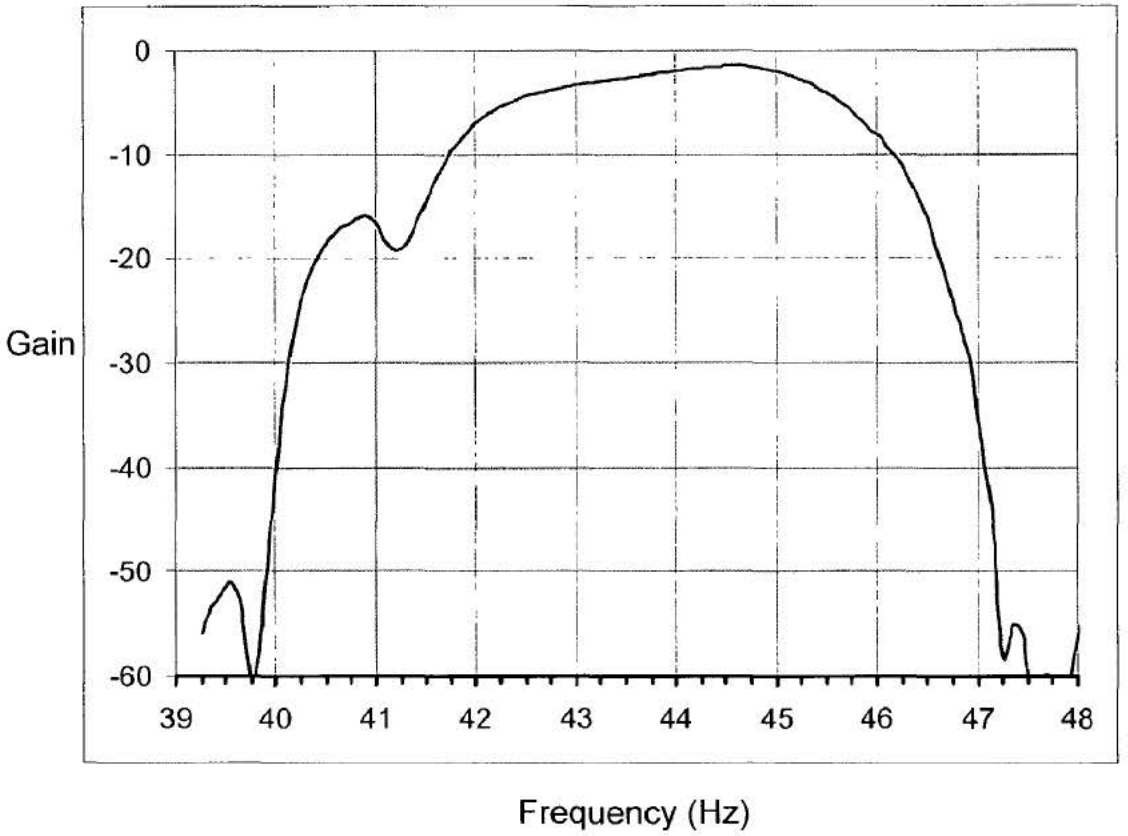

Figure 5

BROADBAND RECEIVER HAVING A MULTISTANDARD CHANNEL FILTER

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims the benefit of U.S. Provisional Patent Application No. 60/322,548, filed Sep. 17, 2001, and entitled "Broadband Receiver for Multistandard Analog TV, Digital TV, and Data Channels", which application is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates to a television signal receiver, and in particular, the present invention relates to a broadband television signal receiver for receiving multi-standard analog television signals, digital television signals and data channels.

DESCRIPTION OF THE RELATED ART

A television or video recorder includes a television signal receiver (or television receiver) to receive terrestrial broadcast, cable television or satellite broadcast television signals and to process the television signals into the appropriate video signals for display or for recording. Television signals are transmitted in analog or digital formats and in accordance with a variety of standards. For analog television transmission, the NTSC (National Television Standards Committee) standard, the PAL (Phase Alternate Lines) standard, and the SECAM (Sequential Couleur Avec Memoire) standard are widely adopted. On the other hand, for digital television transmission, the DVB (Digital Video Broadcast) format and the ATSC (Advanced Television Standards Committee) format are available. Because the different television formats and different television standards are incompatible, television receivers are traditionally made specifically for the analog or digital format and for a specific standard. Thus, televisions or video recording equipments are dedicated equipments which can only be used in the geographic regions in which the television standard is broadcasted.

Multi-standard equipments are known. In most instances, multi-standard equipments are built by duplicating the hardware necessary to receive television signals in different formats and in several standards, increasing the complexity and the cost of manufacturing the equipments.

FIG. **1** is a block diagram of a conventional television receiver. The operation of television receiver **10** includes two main components. First, receiver **10** receives the incoming signal and converts the incoming radio frequency (RF) signal to an intermediate frequency (IF) signal. Then, receiver **10** converts the IF signal to the baseband signals. The baseband signals are coupled to appropriate video and audio decoders to generate the display signals (e.g. RGB) or sound.

Referring to FIG. **1**, television receiver **10** includes a tuner **14** for receiving the input RF signal on input terminal **12** and converting the RF signal to an IF signal by one or more frequency conversions. The frequency conversions are generally implemented as single or dual super-heterodyne conversions. In conventional television receivers, the intermediate frequency is dictated by the geographical area the receivers are to be used. Currently, there are five intermediate frequencies being used in the world. For example, in the United States, the IF is 41 to 47 MHz.

Television receiver **10** includes a channel filter **18** and a demodulator **20** for converting the IF signal to video and audio baseband signals. Channel filter **18** is typically a discrete filter implemented as a SAW (Surface Acoustic Wave) filter. The shape of the SAW filter is designed specifically for the format (analog or digital TV) and the television standard (NTSC, PAL or SECAM) of the television signals being received. Demodulator **20** is typically a dedicated component and designed specifically for a predetermined television signal format and a predetermined television standard.

When television receiver **10** is a multi-standard receiver, a bank of channel filters **18***a* to **18***c* is provided, each of the channel filters designed for a specific format and standard. To support multi-standard reception, a bank of demodulators **20***a* to **20***c* is also provided, each demodulator receiving filtered signals from a corresponding channel filter. For analog television signal reception, the demodulator is a VIF/SIF module. The VIF/SIF module provides a video output called CVBS (Composite Video Baseband Signal) and audio outputs, such as MPX or A2. For digital television signal reception, the demodulator is a digital demodulator typically including a down-converter, an analog-to-digital converter and other supporting circuitry to perform the demodulation. The digital demodulator outputs data in a MPEG data stream.

The conventional multi-standard television receivers have several shortcomings. First, conventional television receivers use discrete analog and digital components. The receivers are typically bigger in size and more costly to manufacture. Second, the conventional multi-standard television receivers require duplicate components to support the different television standards. Consequently, such multi-standard television receivers are large in dimensions and costly to manufacture.

Therefore, it is desirable to provide a multi-standard television receiver that is cost effective to manufacture and has acceptable performance when receiving television signals from a variety of sources.

SUMMARY OF THE INVENTION

A television (TV) receiver includes a multi-standard channel filter with a programmable intermediate frequency adapted to receive television signals in a variety of television standards and formats.

According to one embodiment of the present invention, a receiver includes a tuner and a channel filter. The tuner receives input RF signals encoding information in one of a number of formats and converts the input RF signals to intermediate signals having an intermediate frequency (IF). The intermediate signals are coupled to the channel filter. The channel filter includes an anti-aliasing filter for filtering the intermediate signals, an analog-to-digital converter for sampling the filtered intermediate signals and generating a digital representation thereof, and a signal processor for processing the digital representation of the intermediate signals in accordance with the format of the input RF signal. The signal processor generates digital output signals indicative of information encoded in the input RF signal.

In one embodiment, the formats of the input RF signals include analog television signals and digital television signals.

In another embodiment of the present invention, the receiver further includes a bank of demodulators, each coupled to receive digital output signals from the signal processor. Each of the demodulators operates to demodulate

the digital output signals according to one of the formats of the input RF signal and generates the corresponding video and audio baseband signals.

The present invention is better understood upon consideration of the detailed description below and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a conventional multistandard television receiver.

FIG. **2** is a block diagram of a television receiver according to one embodiment of the present invention.

FIG. **3** is a circuit diagram of an anti-aliasing filter which can be used to construct the anti-aliasing filter of FIG. **2**.

FIG. **4** is a circuit diagram of an anti-aliasing filter which can be used to construct the anti-aliasing filter of FIG. **2**.

FIG. **5** is a waveform of a filter function that can be implemented in the DSP of FIG. **2** for processing analog television signals.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the principles of the present invention, a television (TV) receiver includes a multi-standard channel filter with a programmable intermediate frequency adapted to receive television signals in a variety of television standards and formats. In one embodiment, the channel filter accepts a preselected intermediate frequency regardless of the standards or formats of the television signals. In operation, the channel filter digitizes the incoming television signals and perform signal processing of the incoming signals in the digital domain. By processing all signals in the digital domain, the TV receiver of the present invention eliminates the need for analog components, such as SAW filters. Thus, the TV receiver of the present invention can be readily integrated in one integrated circuit to reduce the size and the manufacturing cost of the receiver. Furthermore, the TV receiver of the present invention reconfigures the same circuit modules to support multi-standard reception, obviating the need to provide duplicate components.

FIG. **2** is a block diagram of a television receiver according to one embodiment of the present invention. Referring to FIG. **2**, television receiver **50** receives input RF signals, such as those received on an antenna or on a cable line, on an input terminal **52**. The input RF signals are coupled to a tuner **54** which operates to convert the input RF signal to an intermediate signal using one or more frequency conversions. For example, tuner **54** can perform a single or dual super-heterodyne conversion. In one embodiment of the present invention, tuner **54** is a commercially available discrete component and outputs intermediate signals having an intermediate frequency (IF) that is determined by the geographic region of interest. That is, the IF of tuner **54** is based on worldwide standards specified for each geographic region.

In another embodiment of the present invention, tuner **54** is an integrated component of receiver **50**. In that case, tuner **54** can be designed to generate intermediate signals having an intermediate frequency of any values. The IF used by tuner can be the same as or different than the IF specified by the worldwide standards. More importantly, because TV receiver **50** includes a multi-standard channel filter **58**, tuner **54** can use the same IF for receiving analog or digital television signals in any standards. The value of the IF in an integrated tuner is a matter of design choice. In one embodiment, the IF is selected to be 20 MHz or higher.

Next, TV receiver **50** includes multi-standard channel filter **58** for filtering and processing the intermediate signals from tuner **54**. Multi-standard channel filter **58** includes an anti-aliasing filter **60**, an analog-to-digital converter (ADC) **62** and a digital signal processor (DSP) **64**. As described above, channel filter **58** is capable of receiving intermediate signals from tuner **54** having any intermediate frequency. Furthermore, channel filter **58** digitizes the incoming televisions signals and performs subsequent processing in the digital domain entirely. Thus, by applying the appropriate sampling frequency at the ADC circuit and the appropriate signal processing functions at the DSP circuit, channel filter **58** can handle television signals in any format (analog or digital) and in any standard (NTSC, PAL or ATSC).

Anti-aliasing filter **60** performs pre-processing of the intermediate signals from tuner **54** to prevent aliasing from occurring when the intermediate signals are subsequently sampled and digitized by ADC **62**. In one embodiment, anti-aliasing filter **60** can be realized with a SAW filter. In another embodiment, anti-aliasing filter **60** is implemented as shown in FIG. **3** using capacitors and inductors. In yet another embodiment, anti-aliasing filter **60** is realized with transconductors (gmC) **99** as shown in FIG. **4**. After the filtering operation, ADC **62** operates to sample the filtered intermediate signals to generate a digital representation thereof. In the present embodiment, ADC **62** is a 10-bit converter and has a sampling rate of up to 40 megasamples per second.

The center frequency of anti-aliasing filter **60** and the sampling frequency of ADC **62** are selected based on the intermediate frequency of the intermediate signal. In one embodiment, both the center frequency of anti-aliasing filter **60** and the sampling frequency of ADC **62** are set to be at least twice the bandwidth of the intermediate frequency signal. When anti-aliasing filter **60** is constructed using transconductors as shown in FIG. **4**, the center frequency of anti-aliasing filter **60** can be adjusted by varying the voltage Vctrl of transconductors **99**. The sampling frequency of ADC **62** can be adjusted by using a voltage controlled oscillator and a phase locked loop. In the present embodiment, a tuning control circuit **67** is included for adjusting the center frequency of anti-aliasing filter **60** and the sampling frequency of ADC **62**. Tuning control circuit **67** can receive a control signal external to TV receiver **50**, such as a manual control signal from a user. Tuning control circuit **67** can also perform auto-detection of the intermediate frequency of the intermediate signals and adjust the operating frequencies of the anti-aliasing filter and the ADC accordingly.

After the intermediate signal is filtered and digitized, the digital representation of the signal is processed by DSP **64**. DSP **64** processes the digital signals according to the television standard to which the input RF signal is encoded.

In the present embodiment, channel filter **58** includes a standard selection circuit **68** for selecting between the several analog television standards and the several digital television standards. DSP **64** applies the appropriate filter function, such as an impulse response, to the digital signals depending on the state of standard selection circuit **68**. In one embodiment, the coefficients of the filter functions are stored in a look-up table in a memory **70**. DSP **64** retrieves the coefficients from memory **70** to be applied to the incoming digital signals.

DSP **64** is a programmable and reconfigurable processor. In the present embodiment, DSP **64** implements a finite impulse response (FIR) filter which is reconfigured based on

the TV standard selected. Furthermore, in the present embodiment, DSP **64** includes two computing units to speed up the computation time. Specifically, the filtering operations of the real and imaginary parts in the frequency domain are carried out in parallel. In other embodiments, DSP **64** may include only one computing unit.

Standard selection circuit **68** can be implemented in one of many ways. The selection of the correct standard can be made manually by the user of the television system, such as by activating a switch, or the selection can be made automatically by providing an auto-detection capability in TV receiver **50**. In the present embodiment, auto-detection is implemented by detecting in the baseband signals the presence or absence of carrier signals which uniquely identify the television standards. For example, analog television signals can be identified by the analog visual carrier signal while digital television signals can be identified by the pilot carrier. Each demodulator in bank **66** generates a signal which is fed back to standard selection circuit **68** indicating which television standard the input signal is encoded. In other embodiments, other means for selecting between the different standards can be used.

When the input RF signal is an analog television signal, DSP **64** applies a video filter function and a sound filter function to the digitized signals to separate the video signals from the audio signals. The video and sound filters can be implemented as FIR filters. An example of such filter function is shown in FIG. **5**. DSP **64** can also implement other filter functions such as ghost cancellation for reducing the interference of the input signal. The filter response is then derived from the measured channel response.

When the input RF signal is a digital television signal, DSP **64** applies a filter function to the digitized signals. The filter function can be implemented as a FIR filter. An example is the ATSC-VSB standard where the filter response is specified as raised root cosine with 0.114 roll-off (refer to the ATSC A-83 specification). Furthermore, additional filter functions, such as an equalizer for echo cancellation (multipath), can also be implemented in DSP **64**. The filter response is then derived from the measured channel response.

The output signals from channel filter **58** are coupled to a bank of demodulators **66** for generating into the appropriate video and audio baseband signals. The video and audio baseband signals are usually coupled to video and audio decoders before being displayed or playback on a view screen.

In the present embodiment, demodulators **66** include a demodulator for analog television signals **66***a*, a demodulator for digital television signals **66***b* and a demodulator **66***c* for digital data channels.

Analog demodulator **66***a* performs demodulation of the analog television signals in the digital domain. In cases where analog demodulator **66***a* receives analog input signals only, a digital-to-analog converter (DAC) (not shown) can be included between the output terminal of DSP **64** and the input terminal of analog demodulator **66***a*.

Analog demodulator **66***a* provides three output signals: a Composite Video Baseband Signal (CVBS) containing the video information, and audio **1** and audio **2** containing the audio information. Audio **1** and audio **2** signals can be AM modulated, FM modulated or Intercarrier signals. The intercarrier signal is a signal that can contain any format of modulated sound. It is usually connected to an external audio decoder. By using standard output signals, TV receiver **50** can readily interface with other standard components, such as a video and sound decoder, thereby providing compatibility with existing television components. An additional digital-to-analog converter may be coupled to the output terminal of demodulator **66***a* if analog output signals are desired.

Digital demodulator **66***b* operates to decode the incoming digital television signal. Typically, digital television signals are modulated in a VSB, QAM or COFDM scheme. Digital demodulator **66***b* generates an MPEG data stream as output signals, thereby providing compatibility with other existing television components.

In one embodiment of the present invention, TV receiver **50** is an integrated circuit where tuner **54**, channel filter **58** and demodulators **66** are all integrated onto the same piece of integrated circuit. In another embodiment, TV receiver **50** can be manufactured as two or more integrated circuits.

The advantages of the television receiver of the present invention are numerous.

First, the television reciever of the present invention can be configured as a broadband receiver for receiving multi-standard analog or digital television signals, and broadcast data channels. Furthermore, the receiver can be configured to receive analog television channels from different television standards. Thus, the television receiver can be readily adaptable for use worldwide for television reception.

Second, the television receiver of the present invention can be used to receive television signals distributed in any manner and provides excellent reception performance. Thus, the TV receiver of the present invention can be used for the reception of terrestrial broadcast and cable transmission.

Third, the television reciever of the present invention eliminates the needs for analog components, such as SAW filters. Therefore, all the circuit modules of the TV receiver, including filtering functions, equalizer, ghost cancellation and video and sound splitter can be integrated onto the same integrated circuit. Increasing the level of component integration has the effect of reducing the size of the receiver and the manufacturing cost thereof.

Lastly, the television receiver of the present invention provides interfaces that are compatible with interfaces of existing components. Specifically, the television receiver of the present invention provides video, audio and MPEG output signals that are compatible with analog or digital television standards so that the receiver can be readily adapted into existing television systems.

The above detailed descriptions are provided to illustrate specific embodiments of the present invention and are not intended to be limiting. Numerous modifications and variations within the scope of the present invention are possible. The present invention is defined by the appended claims.

We claim:

1. A receiver comprising:

a tuner for receiving input RF signals and for converting said input RF signals to intermediate signals having an intermediate frequency (IF), said input RF signals encoding information in one of a plurality of formats; and

a channel filter for receiving the intermediate signals, said channel filter comprising:

an anti-aliasing filter for filtering said intermediate signals;

an analog-to-digital converter for sampling said filtered intermediate signals and generating a digital representation thereof;

a signal processor for processing said digital representation of said intermediate signals in accordance with said format of said input RF signal, said signal

processor generating digital output signals indicative of information encoded in said input RF signal; and

a plurality of demodulators, each coupled to receive output signals from said signal processor, each of said demodulators for demodulating said digital output signals according to one of said formats of said input RF signal, each of said demodulators generating video and audio baseband signals corresponding to said format of said input RF signal.

2. The receiver of claim **1**, wherein said plurality of formats comprise an analog television format and a digital television format.

3. The receiver of claim **1**, further comprising:

a digital-to-analog converter coupled between said signal processor and a first one of said plurality of demodulators, said digital-to-analog converter converting said digital output signals to an analog format.

4. The receiver of claim **1**, wherein said intermediate frequency comprises a frequency value specified by one or more television standards.

5. The receiver of claim **1**, wherein said intermediate frequency comprises a frequency value other than those specified by one or more television standards.

6. The receiver of claim **1**, wherein a center frequency of said anti-aliasing filter and a sampling frequency of said analog-to-digital converter are functions of said intermediate frequency.

7. The receiver of claim **6**, wherein said channel filter further comprises a tuning control circuit for adjusting said center frequency and said sampling frequency to frequency values derived from said intermediate frequency.

8. The receiver of claim **1**, wherein said anti-aliasing filter comprises a transconductance (gmC) filter function.

9. The receiver of claim **1**, wherein said analog-to-digital converter is a 10-bit converter.

10. The receiver of claim **1**, wherein said signal processor applies one of a plurality of finite impulse response filters to said digital representation of said intermediate signal, each of said plurality of finite impulse response corresponding to a format of said input RF signal.

11. The receiver of claim **10**, wherein said plurality of finite impulse response filters are stored in a memory, and said signal processor indexes said memory to retrieve one of said plurality of finite impulse response filters.

12. The receiver of claim **10**, wherein said signal processor comprises a first computing unit and a second computing unit, said first computing unit processing a real part of said finite impulse response filter operation while said second computing unit processing an imaginary part of said finite impulse response filter operation.

13. The receiver of claim **10**, wherein said channel filter further comprises a standard selection circuit coupled to said signal processor, said standard selection circuit generating a select signal indicative of a format of said input RF signal and said signal processor selecting a finite impulse response filter in response to said select signal.

14. The receiver of claim **13**, wherein said standard selection circuit generates said select signal in response to an input signal from a user.

15. The receiver of claim **13**, wherein said standard selection circuit generates said select signal by detecting carrier signals identifying one of said formats of said input RF signals.

16. The receiver of claim **1**, wherein said input RF signals comprise RF signals received from one of terrestrial broadcast, from satellite broadcast, and from cable transmission.

17. A method for receiving input RF signal comprising:

receiving said input RF signals encoding information in one of a plurality of formats;

converting said input RF signals to intermediate signals having an intermediate frequency;

applying a first filter function to said intermediate signals, said first filter function being an anti-aliasing filter and having a center frequency;

digitizing said filtered intermediate signals at a sampling frequency;

processing said digitized signals in accordance with said format of said input RF signals and generating digital output signals indicative of information encoded in said input RF signals; and

demodulating using a plurality of demodulators said processed digitized signals to generate baseband signals corresponding to said format of said input RF signals.

18. The method of claim **17**, wherein said plurality of formats comprise an analog television format and a digital television format.

19. The method of claim **17**, wherein said processing said digital signals is performed in response to a select signal indicative of said format of said input RF signal.

20. The method of claim **19**, further comprising:

generating said select signal by detecting carrier signals in said input RF signal identifying said format of said input RF signal.

21. The method of claim **17**, wherein said center frequency and said sampling frequency are functions of said intermediate frequency.

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